CONTRIBUTION OF INDEPENDENT POWER PRODUCERS IN THE POWER MANAGEMENT OF BANGLADESH

By

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A Project thesis submitted to the department of Industrial & Production Engineering, Bangladesh University of Engineering & Technology, Dhaka, in partial fulfillment of the requirements for the degree of MASTER OF ENGINEERING in Industrial & Production (IP) Engineering.

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DECLERATION

It is here by declared that this project thesis or any part of it has not been submitted elsewhere for the award of any degree or diploma.

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CONTENTS

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Md Maniruzzaman Akan

ABSTRACT

Bangladesh is a developing country. The development of any country largely depends on the availability of electricity. Generation of electricity and its supply to potential consumers in exact quantity and quality is therefore important. The availability of a reliable and economic form of energy is a pre-requisite for economic and social development as clearly demonstrated by the close relationship between growth in industrialized countries and their higher level of commercial energy consumption. Persistent energy deficiency and the low standard of living in many developing countries like India, Bangladesh, Pakistan, Bhutan, and Nepal etc. also proves that the use of electricity is one of the indicators of national development.

In Bangladesh the level of electricity consumption is very low. Only 25% of the population has access to electricity The expected expansion is not taking place due to lack of power availability and lack of delivery infrastructure.

The present installed (July 2001) generation capacity is 4005 MW, while the generation capability is only 3830 MW Out of this installed generation capacity 3320 MW 82 90%) can be generated by BPDB and 685 MW (17.10%) by IPPs. The IPPs are paid in foreign currency under separate power purchase agreements between GOB, BPDB, REB and the IPPs. The maximum demand that could be supplied so far was only 3033MW against a demand of about 3394MW in 2000-01 Comparing the demand with the generation capability, the reserve capacity is only 13%, which results in frequent load shedding. To avoid and minimize the load shedding more generation is the only way to solve the crisis The future power generation plants are required for the greater interest of the nation.

Independent Power Producers (IPPs) has come up with some capability in a shorter time frame compared to that by the government. But the experience of IPP in both developing and developed countries is not always encouraging. This study focused on the overall management of the power system in the country and identified the impacts of IPPs in the system.

It is observed in the study that power from the IPPs were a relief in the time of acute power crisis However, some of the initial contracts were very costly. At present the share of generation by the IPPs is less than the comfortable reserve margin of a system (about 30%). For strategic reason the share of IPPs should not be more than the above margin. In terms of day-to-day share of the IPPs, different allocation ratio results in different cost of production. The study focused that overall cost of generation can be reduced by changing the generation mix

LIST OF ABBREVIATIONS

GOB	Government of Bangladesh
MEMR	Ministry of Energy and Mineral Resources
EPWAPDA	East Pakistan Water And Power Development Authority.
BPDB	Bangladesh Power Development Board.
WAPDA	Water and Power Development Authority.
WDB	Water Development Board.
PDB	Power Development Board.
REB	Rural Electrical Board.
DESA	Dhaka Electric Supplying Authority
PGCB	Power Grid Company of Bangladesh.
IPP	Independent Power Producer.
LDC	Load Dispatch Center.
KPCL	Khulna Power Company Limited
PBS	Palli Bidyut Samity.
PPA	Power Purchase Agreement.
SBU	Strategic Business Unit.
VAT	Value Added Tax
LD	Liquidated Damage.
NLDC	National Load Dispatch Center.
GC	Guaranteed Capacity.
FT	Fuel Tariff.
OMT	Operation and Maintenance Tariff
DI	Dispatch Instruction.
IOC	International Oil Company

Key Definitions

Annual Capacity Test- means the test to be conducted each Contracted Year under the PPA or any of its retests thereof conducted under agreed section to determine the Dependable Capacity of the Facility.

Bank Rate- is the interest rate announced by Bangladesh Bank from time to time.

Capacity – The capacity of the plant express in MW to generate and deliver the Net Electricity Output of the Delivery Point, assuming the continued connection and proper operation of the BPDB's System

Capacity Test – A test of the normal full load capacity of the plant carried out in accordance with the requirement of PPA.

Change in Law- Means (a) the adoption, promulgation, change, repel or modification after the date of this Agreement of any Legal Requirement, including any change in tax (b) the imposition upon the company, its contractors, the Lender, of a fuel supply of any material condition in connection with the issuance, renewal, extension, replacement or modification of any authorization after the date of this Agreement that in either case

(1) Establishes requirements for the construction, financing, ownership, operation and maintenance of the project that are materially more restrictive than the most restrictive requirements in effect as of the date of this Agreement or (2) has a material and adverse effect on the company, the project or the return (net of tax) to the investors of the company.

Combine Cycle Unit- means the unit formed by two gas turbines, the steam turbine and supplementary equipment for generating electric power comprised within the facility.

Commissioning – Taking all steps necessary to put the plant in to operation including carrying out tests prior to operation as specified in PPA.

Contracted Capacity – Plant capacity +/- 10% of reference conditions that the company has proposed to build, own and operate under this Agreement.

Control Center – The load Dispatch center located in Dhaka, or such other control center designated by BPDB from time to time (but not more than on at any time) from which BPDB shall Dispatch the plant.

Delivery Point – the point of common coupling on BPDB's System of which Net Electrical Output from the plant in delivered as specified in PPA.

Exchange Rate- means one any Business day, the rate of exchange for the conversion of taka in to US Dollars as announced by the Bangladesh Bank to be in effect on such Business Day.

Foreign Currency- means any currency other than the currency of Bangladesh, Taka.

Fuel – refers to Natural Gas and liquid fuel, necessary for the operational requirement of the plant as per the PPA.

Gas Price – means the price per MSCF of gas (including Taxes payable in Bangladesh on the purchase and sale of gas and the transportation cost to the point of Delivery) in effect form time to time.

Guarantee – means the Guarantee issued by the GOB to the company pursuant to the Implementation Agreement.

Guaranteed Capacity- the capacity of the plant (in MWs) established by the most recent capacity test conducted during commission of the plant or therefore (taking in to account any permitted retest there of) in accordance with PPA

IPP- Independent power producer is a power generating company in private sector.

Investor- means the holders from time to time of any share of the company with voting or other rights of management and control and any securities of the company that are convertible into such shares at the option of the holder.

LDC- Load dispatch center is a sub department of BPDB who constantly maintain the load demand, and dispatch the load to respective demanded area.

Liquidated Damage (LD) Amount- The amount is payable by BPDB to the contracted company due to BPDB's fault or by the company to BPDB due to company's fault is called Liquidated Damages These sorts of imposing obligation to work under agreement condition.

Lenders- means the lenders party to the Financial Agreements together with their respective successors and assigns.

Long-run-marginal cost (LRMC).-The conventional, idealized approach to setting tariffs for grid electricity is based on an estimation of the long-run-marginal cost (LRMC) of service for different consumer classes, adjusted, for social reasons, and also allowing cross-subsidization among classes and permitting full cost of recovery and financial viability for integrated monopolies. The LRMC concept has historically been kept as a reference point in Bangladesh, but never fully applied for practical difficulties. The BPDB and DESA tariff were introduce in 1987 and modified in 1992. Although the recommended tariff level was based on Long Run Marginal Cost, the actual tariff implemented fall far short of the LRMC tariff. In 1993, the average tariff (based on LRMC) should have been 3 48 TK per Kwh; the actual average tariff rate was 2.32 TK per Kwh, which was 67% of LRMC.

National Load Dispatch Center-A new and modern National Load Dispatch Center should be established to control and manage the loads in respect of PSMP. LDC at Siddhirgong cannot cope up with their present situation.

Net Electrical Output- net electrical energy expressed in Kwh delivered to the Delivery point by the company for sate to BPDB during testing and commissioning of the plant and following the full commercial Generation Date, who dispatch by BPDB.

National Grid- Is a Transmission line, where constantly 230 kv voltage is maintain for transmitting the power in all over the Bangladesh.

Power factor- The product of effective voltage by effective current in an ax circuit is called volt-amperes. A large unit is kilovolt-amperes, abbreviated kva. Obviously, a given number of volt-amperes may represent any number of different values of power, depending upon the value of cos 8 in equation P= VI cos 8. Cosine 8 is therefore a factor by which volt-ampere are multiplied to give power. Hence cosine 8 is called power factor. As an equation

$$\text{Power factor} = \text{Cosine}\theta = \frac{\text{Power}}{\text{volt-amperes}}$$

PGCB- Power Grid Company of Bangladesh, a private Transmission company works to Transmit power with tk. 0.17 per kWh consumption by BPDB, DESA & REB. Presently works on the transmission sector from Meghnaghat to Haripur & 45 km Transmission line of BPDB

Reimburse- is an economic and business term, means the invested amount by any party for his use will be refundable after commercial operation.

REB- Rural Electrification Board is the private power distributing organization, which works to plan, supply & develop the electric power for the rural people by purchasing power from BPDB

Sub-Station- Is an electric supplying station where voltage can be stepped up and stepped down.

Standard- means the environmental guidelines lay down by the World Bank Environmental Guidelines

VAR- Reactive volt-amperes are expressed in vars, a term coined from the first letter of the words "volt amperes reactive" Reactive volt-amperes considered over a period of time represent oscillation of energy between the source and the load. Their function is to supply the energy for magnetic fields and changing capacitors, and to transfer this energy back to the source when the magnetic field collapses or when the capacitor discharges.

CHAPTER-01

Electric power in Bangladesh

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1.1. Introduction

Bangladesh is a developing country The major development thrust of the country in the future must come from the agricultural and farm sector as well as from industrial sector Agricultural sector is increasingly becoming a power intensive sector. Development of industry and service sector is totally dependent on energy and power. The availability of electricity is, therefore, a precondition of national development.

The country has been facing shortage of power generation for the last few years mainly because of inadequate generation capacity and increased rate of requirement of electricity This gap between demand and supply not only discourages new investment in industry; it also results in low quality supply. The electricity demand rate is expected to increase further in the future The situation is not likely to improve unless some generation capacity is added to the system quickly. To meet this demand and supply gap the Government in 1996 formulated a policy allowing private power generation in the country. Historically policy of generating power in private sector is not new in the country.

1.2. Historical Development of the Power Supply System

In 1947, when the Indian subcontinent became independent from the British colonial rule, this geographical part of the sub continent had only 21 MW of electricity generating capacity for households, mills, factories, tea garden and railway workshops etc. These enterprises had their own captive power or were supplied by small private electricity supply companies. A year later, Electricity Directorate under the ministry of industry came into being and soon started taking over the small companies. The Directorate started to build diesel power plant in a planned way- first in Siddirganj and later in Doublmooring and Goalpara By 1960 the electricity directorate, which was merged the previous year with the newly created high-powered Water and Power Development Authority (WAPDA), built about 82 MW new diesel and steam power plant. On the other hand, the irrigation department launched the process of building 80 MW hydro power station at Kaptai on the Karnafully River This capacity was increased to 230 MW (Five units) in different phases by 1980 Simultaneously, a 132 KV transmission line was built in the early 1960 between Kaptai and Dhaka. This transmission line is still in operation with reduced capacity and risky operating condition In the next decade, the generation capacity rose from 88 MW to

419 MW and transmission line from 482 km to 827 km and the demand which was 42 MW in 1960 rose to 214 MW in early 1970.

After the liberation war, Bangladesh emerged as an independent and sovereign country in 1971. The erst while WAPDA was bifurcated into two boards, namely, Water Development Board (WDB) and Power Development Board (PDB) In 1972, Bangladesh Power Development Board (BPDB) was created as an integrated state organization with an installed capacity of 550 MW. During the war of liberation, power installations suffered extensive damage. As a result, the peak demand dropped to 30 MW from the 225 MW of the pre liberation level of 1970.

After the independence, the immediate problem was the rehabilitation of power supply. By the end of 1972-73 the government undertook rehabilitation and development program in the first five-year plan (1973-78) By 1974, the installed capacity rose to 667 MW, when the generating capacity increased to 490 MW. The highest demand at that time was only 266 MW, leaving reserve margin of 46%. In the next two year plan (1978-1980) and then the second plan (1980-1985) period, several projects, initiated before the liberation war, were completed and a number of new projects were undertaken As a result installed generation capacity increased to 882 MW while the peak demand rose to 462 MW. The reserve margin at that time was 47.62%

During the second plan period, the most important achievement was the construction of the East-West electrical interconnector, which enabled the transfer of gas-based low cost power from the East to the West Five power generation plants having a total installed capacity of 330 MW were completed during this period. But generation capacity still lagged behind the demand. The main constraint to the expansion of power supply was the shortfall of the resources coupled with a huge system loss and a slow response to tariff adjustments against rising fuel cost.

By the middle of the third plan (1985-90), the system loss stood at 37.5%. Due to such a high system loss, low account received, high load shedding, poor management and inability to improve the performance, consessional loans for the power sector from the multilateral donors were not available in most part of the Fourth plan (1990-95) period. The operational capacity (2133 MW) was again interrupted by occasional power outages owing to fluctuations in gas pressure, transmission and distribution faults. During this period, inadequate government resources could add only about 581 MW to the country's net generation capacity. However, due to non-completion of scheduled rehabilitation of some power stations, generation capability decreased by 271 MW and about 11 MW capabilities was retired during this period. The net capacity increase was thus 299 MW against a new demand of at least 1000 MW as per growth rate during the same period. This led to a shortfall of generation of about 700 MW and led to chronic load shedding in 1996 and 1997. In September 1997 Raozan-2 (210 MW) power station come in to operation and the first private power company (100MW) was commissioned in October 1998.

In spite of these, it has not been sufficient enough to meet the ever-growing demand It is thus no wonder that after more than two decades since independence, more than 80% of the whole population is still being denied the access to electricity.

However, to meet the demand of electricity of rural people an autonomous corporation named Rural Electrification Board was formed and functioning since October 31, 1977. REB purchases electricity from BPDB and sells to the end user through PBSs (Palli Bidyut Samities), which is a democratic, decentralized, and autonomous cooperative organization. In PBSs the cooperative member consumers enjoy equal opportunities and are entitled to exercise equal rights. Till now 419 Thanas are electrified through REB Organizational developments in the electric power sector at different times is illustrated in figure: 1.1.

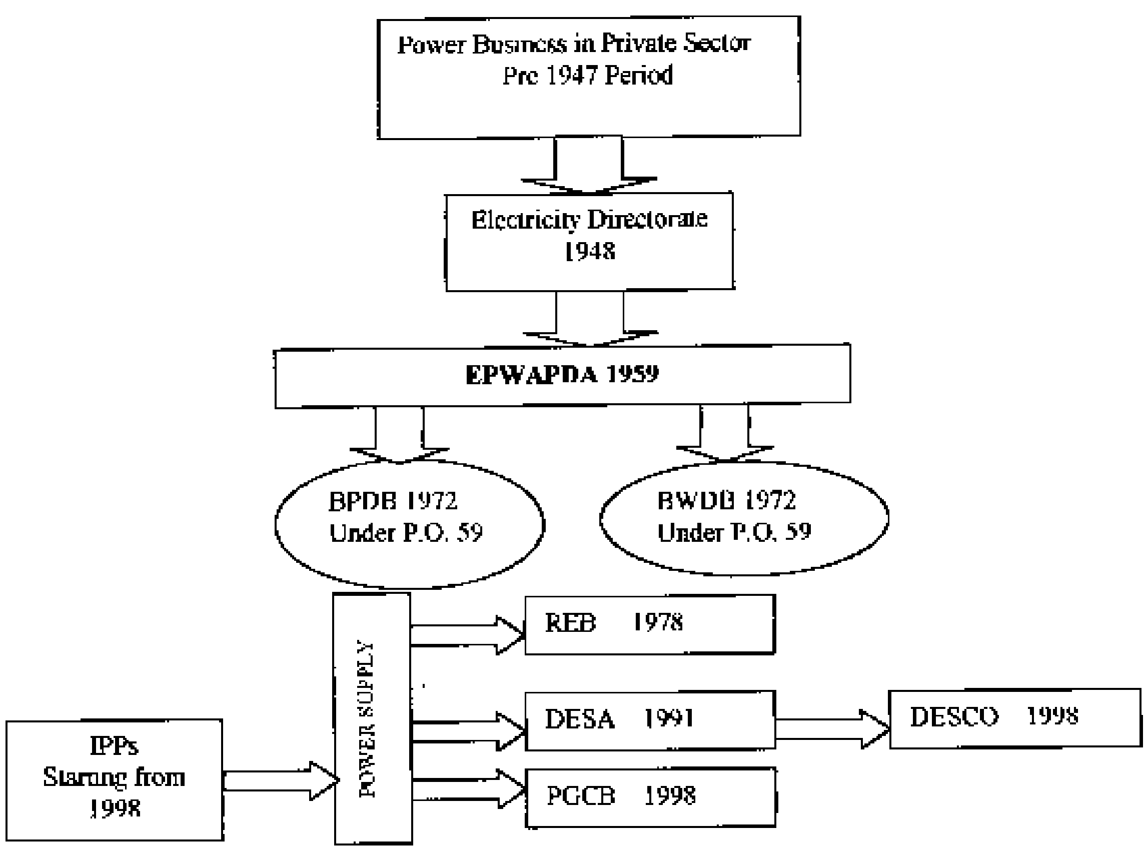


Figure 1.1: Historical development of organizations active in electric power sector of Bangladesh.

1.3. Power Management System in Bangladesh.

1.3.1. Administration.

The Government of Bangladesh has a separate ministry of energy and mineral resources to control, monitor, and supervise, the power and energy sector These are two divisions in the ministry viz. Energy Division and Power Division. BPDB is a semi autonomous organization, which deals with electric power management in Bangladesh.

In the power generation sector BPDB and IPP respectively produce 82.90% & 17.10% of present generation Very soon REB will also come in generation with 11x10MW generation plants. BPDB and newly formed PGCB (Power Grid Company of Bangladesh) are in charge of transmission of the generated power

BPDB, DESA, DESCO, REB is distributing the power to the end user. DESA, DESCO, & REB purchase power from BPDB in bulk amount and then distribute to consumer. Figure 1 2 shows the administrative and business links between different organizations of the power system.

The management of BPDB has been vested on a Board, consisting of a Chairman and six members. Each member looks after different areas like Administration, Finance, Planning & Development, Generation, Transmission and Distribution At present about 24 thousand officers and staffs work in BPDB. Administrative systems of other organizations in figure 1.2 are briefly discussed bellow.

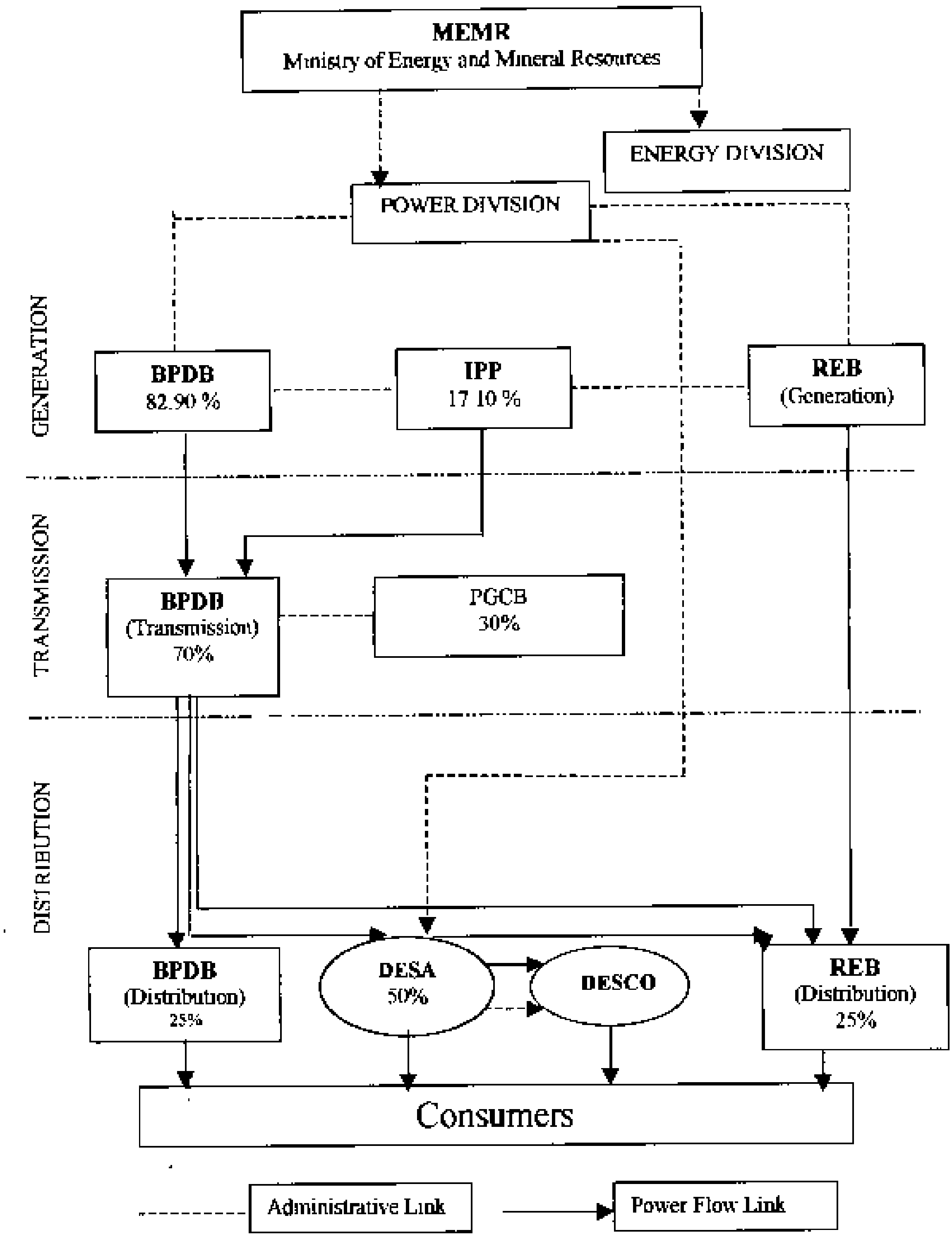


Figure 1.2: Administrative and business links between organizations of the power system.

REB

In order to intensify the pace of rural electrification, the government issued an ordinance in 1977 establishing the Rural Electrification Board (REB), a semi-autonomous agency charged with the responsibility of planning, developing, financing, and construction of rural distribution networks. REB promotes the establishment of Rural Electric Cooperatives called PBSs (Palli Bidyut Samities), hands over the constructed rural networks to them and assists the PBSs to operate and maintain the rural networks and monitor their financial performance.

Chairman is the chief executive of the board of REB and is responsible for the overall development, management, and administration of REB and its affiliate establishment (PBSs) etc to carry out the Rural Electrification Programme as defined in the ordinance. He will plan, organize, direct, coordinate, and control all facets of the programme and REB administration through appropriate delegations wherever needed. There are different members for different functions of the board viz. finance, engineering, PBS operation.

DESA

In 1990, another ordinance was issued, which was subsequently enacted as an Act transferring the 132KV and 33KV transmission system and distribution system in the greater Dhaka area including the metropolitan city to a newly created government agency called the Dhaka Electric Supply Authority (DESA).

The Dhaka Electric Supply Authority (DESA) could not start formal functioning from the date of its establishment due to some practical reasons. However, formal functioning and commercial operation of the authority started from 1st of October 1991

DESA took over the electrical distribution network of about 7473 sq kilometer area of the greater Dhaka district, which was previously under the control of BPDB.

DESA started to import electrical power from BPDB at 132KV for the purposes of distributing the same to the consumers within this area. With the formal start up of its operation DESA has to take over the existing manpower of BPDB, those who were working with the Dhaka Electric Supply. All the practices and rules, all the problems and liabilities lying with BPDB also were automatically transferred to DESA With a huge amount of receivable lying outstanding with the consumers and with practically zero bank balance DESA started functioning from 1st of October 1991

The Authority comprising with one Chairman and Members not exceeding three in number was assigned with following functions-

i. Sale and distribution of electricity, maintenance and extension of the distribution system within the greater Dhaka area.

ii Execution of development works related to distribution of electricity to consumers and preparation of planning and design of engineering projects and execution of the same with the prior approval of the government.

iii. Planning, development and maintenance of electrical distribution system starting from 33KV lines and substations down to lower voltages within greater Dhaka area with the prior approval of the government.

iv. Execution of other works related and supplement to the above works.

DESCO

The Dhaka area is the largest single distribution territory consuming about 50% of the total electricity sold in Bangladesh DESA, which is the distribution agency for the Dhaka area has a poor performance record with respect to system losses and accounts receivables. Although the performance has improved considerably since 1992 on account of intensive monitoring, there is a limit to the gains that can be made and it is felt that further progress can be achieved on a sustainable basis only if there is a change in the business environment, both external and internal to the organization, which will enable introduction of more sophisticated control and management system, and also organizational accountability.

The current organizational arrangements including management structure, employee compensation, delegation of authority, conduct, discipline and appeal rules and promotion policies are based on the civil service rules and arrangements which is not well suited to the functioning of a commercially oriented sector such as power sector. It was therefore necessary to create new organization with its own rules and regulations, that are more suited to the new business environment. Subscribing to that a new company (DESCO) was being created as a public sector company, incorporated under the Companies Act as a subsidiary of DESA. In the future, shares of the company will be offered to the private sector, other power sector entities and the general public to make the DESCO's management more responsive to its consumers.

The company is wholly owned subsidiary of DESA DESCO is managed by a part time Board of Directors appointed by its shareholders, which is responsible for policy decisions. Day-to-day managerial decisions are vested with the Managing Director and two full time Directors who are appointed by the Board of Directors They are also be members of the board once appointed. The organization of the company is as follows:

i. The Chairman of the Board of Directors is the Chairman of DESA or his nominee till such time DESA owns the majority of the shares in DESCO.

ii. The Managing Director is the Chief Executive Officer of the company and is responsible for overall management of the company

iii The Director (Technical) is responsible for development planning, supply and demand management, commercial operations and maintenance of the system

iv. The Director (Finance) is responsible for all financial matters of the company.

PGCB

PGCB was created as an outcome of the restructuring process of power sector in Bangladesh for establishing commercial environment including bringing efficiency, accountability and functional autonomy PGCB was incorporated in November 1996 with an initial authorized capital of Tk 10 billion and entrusted with the responsibility to own, operate and expand the National Power Grid Network for transmission of electricity with reliability, security and economy on sound commercial principles.

In accordance with the government decision of transferring the transmission system from Bangladesh Power Development Board (BPDB) and Dhaka Electric Supply Authority (DESA) to PGCB two agreements were signed with BPDB for transfer of four 230kV Sub-stations and 61.5 km 230 kV transmission lines in two segments The assets are now being owned by PGCB and financial transaction for the transfer has been completed. The government has issued the tariff notification for the said transferred assets. A programme has been submitted to the government and other concerned entities for transfer of whole transmission system by December 2002. The government has already notified the global transmission tariff, which will be effective after transfer of the transmission system fully to PGCB.

PGCB envisaged to run the system with minimum but skilled manpower for bringing efficiency and economy. Keeping this in view, PGCB board has approved the organogram with 1615 personnel for managing the entire transmission network of the country including load dispatching. Chairman BPDB, will be the chairman of the Board of Directors of PGCB The board having 8 Directors where chairman is the chief and 3 other members will look after the management system of PGCB. Managing Director is the chief of executive management and Director (Technical) and Director (Finance) looks after the technical and financial matters respectively Security and cleaning service were planned to be contracted out.

1.3.2. Generation

The present installed generation capacity of the country is 4005MW(including 685MW from IPP), out of which indigenous gas based capacity is 3286MW, hydro-based capacity is 230MW and oil based capacity 494MW.

According the Statistics on Commercial Operation of BPDB [27], in July 2001 the net energy generated for the month of July 2001 was 1540.538Mkwh. Out of this the gas based generation was 85.93%, hydro was 4.87%, and liquid fuel was 9.20% as shown in the Figure 1.3. Highest demand served was 3084.00MW on July 05, 2001 and maximum load shedding was 328MW. The parts shared by the IPPs combined in that month were 286.004Mkwh. Figure 1.4 shows the share of private and public sector in generating power for July 2001.

The above data shows that the indigenous gas base generation (85.93%) having the major share of generating electric power. But the gas deposition in Bangladesh has capability to run up to year 2019[28]. After that the generation will depend on diesel, HFO, coal, or nuclear energy. The deposition of gas assessed by Bangladesh Geological Society at present is 11.86TCF[28].

Figure1.3: Generation as on July 2001 by different fuel.

Share of Public and Private Sector

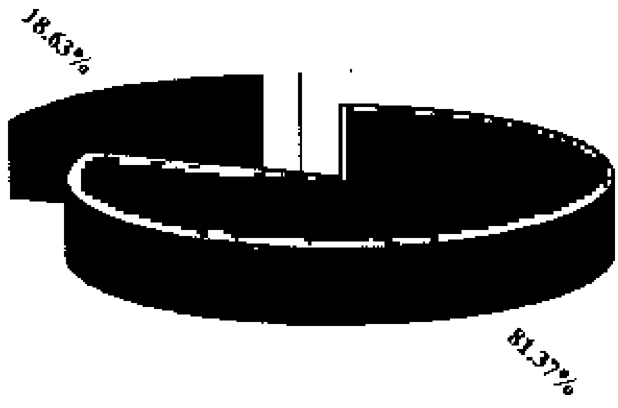


Figure1.4: Share of public and private sector in power generation for July 2001.

Because of shortage of power in the formal systems, the major industries acquire captive power for their own uses in recent years. Although there is no accurate information on the amount of such generation capacity, it is estimated that more than 500MW capacity has been installed as captive power at different industrial units.

1.3.3. Transmission

The National Grid consists of 230KV and 132KV transmission lines. All the power plants are connected with the national grid. Presently we have 570 KM of 230KV and 2531 KM of 132 KV Transmission line. Power is injected in the national grid from different power stations, which is then transmitted to different load centers. At load centers voltage is stepped down at different voltage levels and distributed to the consumer. Table 1.1 shows the ownership of transmission and distribution lines.

Total national grid is gradually being prepared for privatization. The process started in 1996 by handing over 61.5 km of 230KV line to Power Grid Company of Bangladesh (PGCB), a holding company of BPDB. At present PGCB owns 479.5km of 230KV and 653km of 132KV lines. PGCB will charge TK0.17 per kwh transmitted through its transmission lines after December, 2002 when total transmission assets will be handed over to PGCB.

Table 1.1: Existing transmission and distribution lines in km of the utilities as on Jun 2000.

Name of the utilities	Line (km)				
	230 KV	132 KV	66KV	33KV	11KV & below
BPDB	570	2531	167	8203	29422
DESA	0	511	0	952	4450
REB	0	0	0	0	119258
DESCO	0	0	0	45	485
Total	570	3042	167	9200	153615

Existing generation and transmission network all over Bangladesh is shown in Annexure A.

1.3.4. Distribution

The distribution network of the BPDB around the country serves consumer of different category. The number of different category of consumers served by DESA, REB, and DESCO are respectively 489533, 2751403, and 97067 respectively Table 1 2 shows category wise number of consumers of the distribution companies.

Table 1.2: Category wise consumer of various utility companies as of June 2001.

Name of the Utility	Consumer Category					
	Domestic	Commercial	Irrigation	Industrial	Others	Total
PDB	1,043,977	299,896	17,872	46,779	24,293	1,432,817
REB	2,285,859	322,609	79,889	55,137	7,909	2,751,403
DESA	413,564	55,917	179	17,236	2,619	489,533
DESCO	88,232	6,296	0	2,358	181	97,067
Total	3,831,632	684,718	97,958	121,510	35,002	4,770,820

(Note: The others include Mosque, Madrasha, Girza, Pagoda etc.)

1.4. Issues of Electric power System Management in Bangladesh

1.4.1. Administrative Reform

The power system in Bangladesh is controlled by number of agencies namely, the Bangladesh Power Development Board (BPDB), the Dhaka Electricity Supply Authority (DESA), Rural Electrification Board (REB), Dhaka Electric Supply Company (DESCO) and Power Grid Company of Bangladesh (PGCB). Apart from these organizations, number of independent power producers (IPPs) are new partners in the generation part of the system. BPDB is still the major player in the system and its activity is spread across the value chain.

BPDB generates a major part of the total electric power, and distributes major demand area including large cities, municipalities and also many non-municipal load centers. It has four distribution zones namely, Central, Northern, Southern and Western Each zone is divided into a number of Electricity Supply Units (ESU). BPDB still operates certain part of the transmission system. With such coverage BPDB appears to be lost in itself Non-accountability within its different business operations (generation, transmission and distribution) has breeded inefficiency in the organization.

Through the creation of Rural Electrification Board, unbundling of the integrated BPDB took place for the first time in 1977. In 1990, the initial step was taken to formally unboundle a part of BPDB's distribution through the creation of the Dhaka Electric Supply Authority (DESA) as a separate distribution authority for Dhaka in 1991 recognizing that Dhaka alone accounts for over 50 percent or electricity demand. The Power Grid Company of Bangladesh (PGCB) was created in 1996 and incorporated under the Companies Act of 1994. Although a public limited company, this new structure gives the PGCB much greater control to provide incentive and manage its affairs in a company rather than as a government entity.

Dhaka Electric Supply Company (DESCO) was also created in late 1996 and incorporated under the Companies Act, like PGCB. DESCO took control of distribution assets at Mirpur area of Dhaka in 1998.

Since 1996 the Ministry is being assisted by an outfit called the power cell created to advance sector reforms and assists in tariff formulation in the power sector. REB is responsible for expansion of distribution system to rural area through a system of rural co-operatives named Palli Bidyut Samities (PBS), which carries the utility operating functions, 67 PBSs have been commercially established. These PBSs purchase power from BPDB. Recently some PBSs are allowing private power generation within their command areas

Under the reform program in generation and distribution sector, BPDB formed SBU (Strategic Business Unit) to overcome the technical and management problem. In power generation sector Haripur Power Station was made an SBU from December 6, 1999. As an SBU Haripue Power Station took several steps to improve its operational efficiency. The key features of HPS as an SBU are.

1. Own budget.
2. Purchasing Power

3. Autonomy in personnel management
4. Autonomy in operational matters.

The achievement of HPS after its new status was encouraging i.e. plant availability is 90.00 per cent against target of 86.05 per cent, reliability is 98.18 per cent against target of 98.42 per cent and efficiency is 23.00 per cent against target of 23.00 per cent.

In the distribution system Sherpur and Jamalpur district was taken as SBU in 1999 with the aim to increase revenue and reduce unauthorized demand and overall improvement of distribution including load management. At the end of November 2000,100 per cent revenue collection in Jamalpur was achieved and demand was reduced by 0.872MW. In Sherpur SBU 86 51 per cent revenue collection was achieved and demand was reduced by 1.00MW.The above reform programs within BPDB seems to bear positive result.

Out of the present installed generation capacity of 4005MW, 685MW is generated by Independent Power Producers (IPPs), which is 17.10 per cent of total generation. According to PSMP (Power System Master Plan) the generation capability by BPDB will be 5693 MW and by IPP's 2050 MW in the year of 2007. The share of IPPs will be then 26.80 per cent of total generation The gradual devolution of BPDB operations and participation of private sectors in the power sector are going to influence the management of the power system However, there are many factors that need to be considered in this respect, apart from these administrative changes and other issues relevant to power system of Bangladesh.

1.4.2. Alternative Options for Generation

About 90% of the electricity generated in the country comes from gas-fired power plants. However, the gas reserve in the country is limited. The recoverable reserve estimated to be 15.48 TCF. By now about 3.95 TCF has been consumed and the remaining recoverable reserve of gas is around 11.68 TCF.

Natural gas account for about 70 per cent of commercial energy use in Bangladesh Gas consumption grows rapidly, with annual growth rate of 9 per cent. The gas market is dominated by the power and fertilizer sectors, which accounts for 45 per cent and 32 per cent of demand respectively in 2000-01 The growing consumption in power and fertilizer will exhaust the present estimated gas reserve in next 15 [25] years. Therefore, power generation from alternative fuel must be considered for any long-term plan of power system. The probable alternative energy sources in Bangladesh are described below briefly.

(a) Coal

From the energy standpoint, Bangladesh has discovered substantial amount of deep scooted coal deposits in Jamalgonj (Joypurhat District), Barapukuria (Dinazpur District), Khalaspir (Rangpur District) and Dighipara (Dinajpur) over the last 35 years. First commercial coal will be produced from Barapukuria mine some time in 2005.Over 80% of the deposit will be consumed to generate 300 MW of power for 25years

(b) Oil

Exploration activities carried out so far could not discover any significant oil deposit. The only oil deposit so far discovered in the country is in Haripur which produced a total of about 0.65 million barrels of crude oil till 1994. One oil production has since ceased because of reduction of pressure and influx of water in the oil zone. Comprehensive exploration efforts need to mount in the field.

(c) Bio-Mass

Electricity coverage being only 15% of the population and natural gas reaching only 3% of the households, biomass is the major sources of energy in Bangladesh. Over three fourth of total population of the country depend of biomass for cooking, crops drying and winter heating.

(d) Solar Energy

The average daily solar radiation varies from 5 05 kWh/sqm in winter to 8.76 kWh/sqm in summer. At present solar energy is mainly used as a convenient and low cost means of drying crops, fish and salt. Some photovoltaic units have been installed in different parts of the country mainly for demonstration. Capital cost for solar photovoltaic technology for the generation of electricity being costly, its prospects are to be ascertained for specific end uses and locations

(e) Nuclear.

At present Bangladesh has no nuclear power station However a 30MW nuclear power plant is being planned for last few years. It is still uncertain and prospect is negligible.

In term of ownership of generation, BPDB will have to continue adding more power stations. However, depending on the growth rate of demand it might be necessary to allow more IPPs to generate power

1.4.3. Transmission Issues

With the increase in generation over the years, the development of transmission lines fall far short of demand The Power System in Bangladesh is characterized by sharp differences between the eastern sides, where natural gas is available and the less developed western side, which depends on, imported liquid fuels. The share of power plants located on the two sides is approximately 81 per cent and 19 per cent respectively between the east and west. However, the two sides are linked by a 230 KV East West interconnecter built in 1982 that transport surplus power from east to west zone A second interconnection through a 132 KV double circuit line has been completed in 1998 aligned along the Bangabondhu Bridge. The bridge also provides a 30inches dia natural gas pipelines. This will enhance more balanced generation of electricity in the country in future and substantially reduce large high voltage transmission losses

The transmission system consists of high voltage 230 KV and 132 KV grid lines covering the main load centers in the country. However the integrated transmission and the distribution networks are inadequate. The system control center is inefficient, inadequate and is based on low technology for a system of the size and complexity of the Bangladesh's network. Erected in the 1980s LDC at Siddirganj cannot cope even now. The situation is likely to aggravate when IPP generating units, particularly Haripur (360 MW) and Meghnaghat (450 MW), Barapukuria 250 MW and Baghabari 250 MW etc. will come into full operation by year 2005 Different issues that are relevant to the transmission network of the electric power system of the country may be listed as below:

a) Load Management.
b) Inefficient and Inadequate Transmission Lines
c) Losses and Inefficiencies.
d) Operational Constraints.
e) Demand Management.
f) Technical difficulties.

The above matters eventually translate to factors that affects the generation system.

1.4.4. Distribution Issues

The distribution of electric power in the country is the last-step where the customers interact with the providers. There are many technical as well as non-technical issues involved in this step. Issues such as customer satisfaction, demand management, loss minimization, system balancing etc. are issues which eventually affect some aspects of generation. The main distribution issues are as follows

Consumer survey.

Meter testing.

Meter sealing.

Faulty meter replacement.

Regularization of consumer

Neutral & Meter earthing.

Replacement of non-standard service.

System balancing

Re-locating X-former & stringing required lines

Meter re-location.

1.4.5. Techno-Economic Issues

Apart from different technical issues there are certain technological economic and financial aspects of the system in Bangladesh that deserve serious attention Economic life of power stations, transmission and distribution lines determine the cost of production and delivery. Standard economic life for these components are as below [PSMP-1995]:

Hydro plant -	50 years
Steam turbine-	30 years.
Simple cycle combustion turbine-	20 years.
Combustion cycle plant-	25 years
Transmission & Distribution line-	35 year.

Some of the power plants of BPDB have crossed the desired lifetime. Still these plants are running with very risky operating condition At present the average plant factor of BPDB is about 60-64%, and the overall efficiency was 31.59%[5] Some of the plants like Raujan Power Station could not reach the expected efficiency from the beginning. Plants of 1-10 MW capacity are not operated on regular basis. Their efficiency is going down due to idling. As a result when they run during peak load period they show high operational cost. Plants cannot be taken for rehabilitation program, due to financial constraint. The regular & routine maintenance could not be carried out due to insufficient reserve margin. At present no reserve margin is available in power generation sector for schedule maintenance. The old machinery has no repair and maintenance manual for standard maintenance. Insufficient stock of spare parts is also a problem for repair & maintenance. Lack of training opportunities for the new acquired technologies acquisition, aggravates the situation.

BPDB is facing severe financial problem due to certain losses and sale of electricity at lower rate than production cost. At present the generation cost is approximately Tk. 1 71/Kwh including the power purchase cost from IPPs [29]. The transmission & distribution cost is about Tk0.914/Kwh [27 &29]. The total cost at the consumer level is Tk 2.625/Kwh. which is much higher than present tariff rate. The average tariff rate is about Tk 2.18/Kwh. This has led to approximately Tk 300-400 crore losses to BPDB every year On the other hand BPDB purchases power from IPPs at the average rate of Tk 4.50/Kwh. BPDB sells electricity to REB at the rate of Tk 1.84/Kwh and to DESA at Tk. 1.92/Kwh. to their end. At the same time the revenue collection from both REB & DESA is not satisfactory. As per the PSMP, BPDB requires US$ 6 billion to implement the planned programs for next ten years but does not know from where this fund will come. Even BPDB does not have any forecast of expenditure for next few years' improvement plans The problem aggravated further after the donor agencies stopped funding in the power sector.

1.5. Objective of the Study

The power management is mainly a coordinated and integrated effort of generation, transmission, and distribution. All the three components must cooperate and act in unison for smooth management of the system. A complete study of the power system management is quite an involved work. However, study of any one component will definitely lead to issues those have implications on other components. Generation of power is the basic component in the whole power system. In the previous sections different issues of power system of Bangladesh were mentioned Among these the issues related generation deserves special attention. Specially with the advent of IPPs and devolution of generation plants of BPDB is interesting Given the reality that IPPs are going to stay and more of them will be added it is important to understand how these IPPs are going to influence the power system of Bangladesh This study has generally concerned itself with the impact of IPPs in the power system Specific objectives of the study are:

(a) To study and analyze the present electric power system in Bangladesh.

(b) To study the operations of the Independent Power Producers in Bangladesh.

(c) To study the implications of IPPs in the power management system of Bangladesh.

1.6. Methodology

The bulk of the information for the study was collected from secondary sources such as annual report of BPDB and REB, various studies and presentation made by the concerned organizations and individuals The contract documents for the operation of IPPs were reviewed. Besides, data were collected from various sources at BPDB, Power Cell and DESA through personal communications

1.7. Organization of the Study

In the first chapter of the study a general outline of the electric power system of Bangladesh is presented. Major player in the system and important issues related to the management of the system is pointed out.

BPDB being the largest component of the system, its operation and management is described in chapter 2. It is tried to identify the problem areas of BPDB operation and management and possible root causes are sought.

In chapter-3 the independent power production system is discussed. Important points of the contracts of the independent power producers are noted. Contributions of IPPs are also discussed. Also, experience of IPPs in other countries is briefly discussed.

In chapter-4 different strategic options of power generation with IPPs for the electric power system of Bangladesh is discussed.

The study is summarized in chapter-5 and conclusions are presented.

CHAPTER-02

Operation and Management of BPDB.

CHAPTER-02

Operation and Management of BPDB.

2.1 Introduction

The BPDB is an autonomous organization under Ministry of Energy and Mineral Resource. The management is vested on a board, consisting six members, and a Chairman. The latter is the head of this board. Each member oversees an operational area of the of the organization as described earlier. The highest tier of the organizational structure of BPDB is shown in Figure 2.1. The detail is presented in Annexure B.

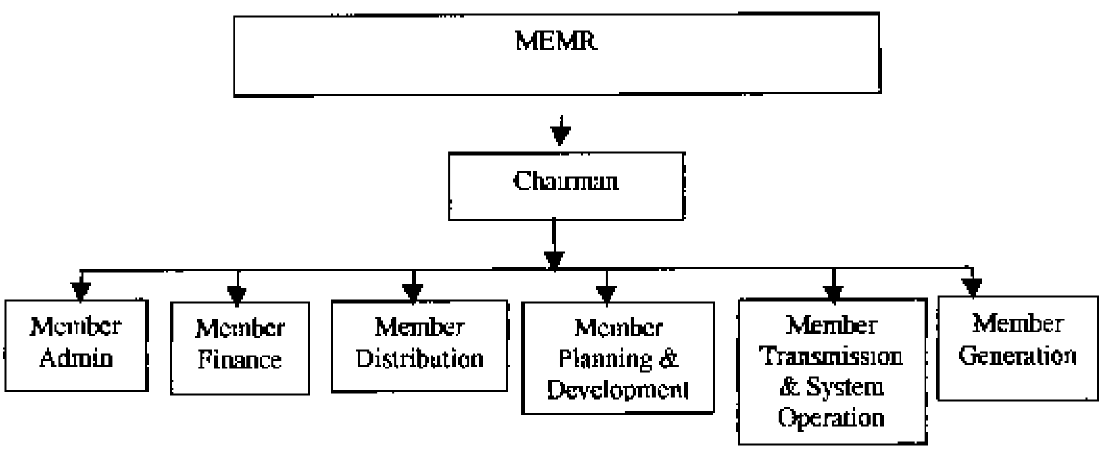


Figure 2.1: Highest tier of the organizational structure of BPDB.

2.2. Generating Stations of BPDB

BPDB has generating capacity of 3711 MW in different power stations located at different places of the country. These power stations have different characteristics This section presents these power stations from different point of view

2.2.1. Type of Power Generating Stations

The technology of power generation depends on types of fuel combustion technology and combination of prime mover. Power generating stations of BPDB covers part of the full spectrum of power generation technology. Table 2 1 presents the type of power stations of BPDB along with generating capacity.

The Hydroelectric power plants use flowing river water at Karnaphully. Other power stations used Diesel oil, Furnace Oil and Natural Gas as primary fuel. For combine cycle power stations the exhaust gas from the primary gas turbine is used as fuel to generate steam in boiler The steam is used to rotate the secondary turbine. The schematic diagram of combine cycle electricity generation is shown in Figure:2.2. The electricity from the Hydro-Electric plants is the cheapest. However, the first cost is quite high. Combined cycle plants are most efficient. BPDB does not have any nuclear, solar or wind energy based power station.

Table 2.1: Generating capacity of BPDB by types of technology.

Technology	Fuel	Capacity	Percentage
Hydro	Water head of reserve.	230MW	7%
Steam Turbine	Natural Gas	2102MW	64%
Steam Turbine	Furnace Oil	170MW	5%
Gas Turbine	Natural Gas	299MW	9%
Gas Turbine	Diesel	297MW	9%
Combined Cycle	Natural Gas	150MW	4%
Diesel Engine	Diesel	29MW	0.9%
Total		: 3277 MW	

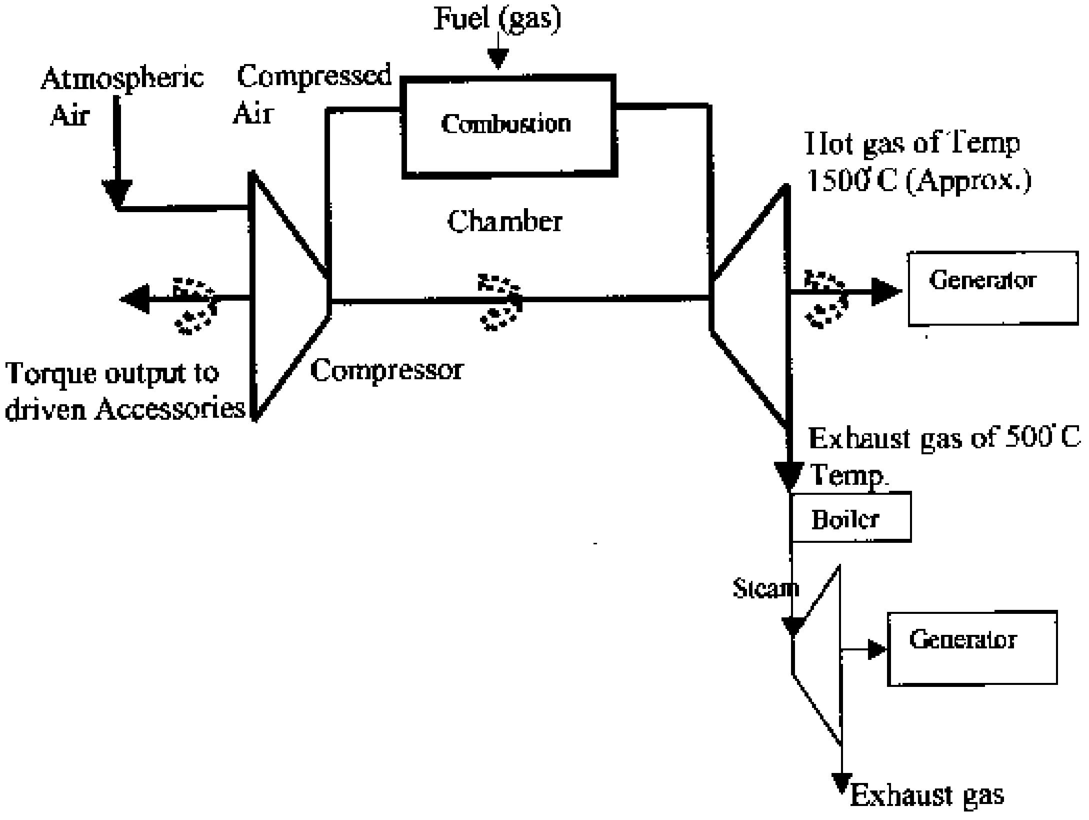


Figure 2.2: Schematic diagram of a combine cycle plant.

From the table 2 1 we can see that power generated from natural gas is the highest (77.80%). However, out of this capacity (2675MW) only 4% is generated by most efficient technology i.e. combined cycle technology. In terms of efficiency plants producing more than 50% of total BPDB production capacity are running at below 30% efficiency [20]. Many plants are running at efficiency range of 12-18%. However, the overall efficiency of the BPDB plants is 31.63%.

2.2.2. Location and Age of Power Stations

Table 2.2: Major Power Stations of BPDB according to location, age and remaining lifetime from the year 2002.

(A.) EAST ZONE (Existing)

SL No	Name of the power Station	Unit No	Unit Type	Commissioning Date (DD/MM/YY	Date of Retirement DD/MM/YY	Type of Fuel	Installed Capacity	Capability	Generation (MW) on		Remaining Life time (Year) As on 2002
									Max Gen. Day	Min Gen. Day	
1	2	3	4	5	6	7	8	9	10	11	12
1	KARNAFULI HYDRO	1	Hydro	26-02-1962	26-01-2012	Hydro	40	40	40	40	10
		2	Hydro	08-1-1962	08-01-2012	Hydro	40	40	40	40	10
		3	Hydro	08-1-1982	08-01-2032	Hydro	50	50	34	35	30
		4	Hydro	11-01-1988	11-01-2038	Hydro	50	50	50	50	36
		5	Hydro	11-2-1988	11-02-2038	Hydro	50	50	50	50	36
2.	ASHUGANJ	1	ST	17-7-1970	17-7-2000	Gas	64	50	50	50	-
		2	ST	08-7-1970	08-7-2000		64	50	50	50	-
		3	ST	17-12-1986	17-07-2016		150	150	150	150	14
		4	ST	04-05-1987	04-05-2017		150	150	150	150	15
		5	ST	17-03-1988	17-03-2018		150	150	150	150	16
		1	CT/CC	15-11-1982	15-11-2007	Gas	56	50	0	0	5
		2	ST	28-03-1984	18-3-2014		34	24	0	0	12
		2	CT	26-03-1986	16-03-2006	Gas	56	50	0	0	4
3	SIDDHIRGANJ	2	ST	29-04-1970	24-04-2000	Gas	50	50	46	46	-
4	HARIPUR	1	CT	03-10-1987	03-10-2007	Gas	33	30	32	32	5
		2	CT	15-11-1987	15-11-2007		33	30	32	32	5
		3	CT	02-12-1987	02-12-2007		33	30	24	25	5
5	GHORASAL	1	ST	16-06-1974	16-6-2004	Gas	55	50	0	0	02
		2	ST	13-02-1976	13-2-2006		55	50	40	40	04
		3	ST	14-09-1986	14-9-2016		210	210	100	0	14
		4	ST	18-03-1989	18-3-2019		210	210	190	0	17
		5	ST	15-09-1994	15-09-2024		210	210	200	0	22
		6	ST	31-01-1999	31-01-2029		210	210	190	210	27
6	SHAHJI BAZAR	1-7	CT	1968-69	1988-1989	Gas	96	70	33	58	-
		8	CT	28-03-2000	28-03-2020	Gas	35	35	35	35	18
		9	CT	03-10-2000	03-10-2020	Gas	35	35	34	35	18
7	FENCHUGANJ CC	1	CT	24-12-1994	24-12-2014	Gas	30	30	33	32	12
		2	CT	31-01-1995	31-012015	Gas	30	30	0	0	13
		3	ST	08-06-1995	08-06-2015		30	30	0	0	13
8	SYLHET	1	CT	13-12-1986	13-12-2006	Gas	20	20	0	0	04
9	RAUJAN	1	ST	28-03-1993	26-03-2023	Gas	210	210	0	0	21
		2	ST	21-09-1997	21-09-2027		210	210	180	0	25
10	SIKALBAHA	1	ST	24-04-1984	24-04-2014	Gas	60	55	51	40	12
		1	CT	13-08-1986	13-08-2006	Gas	28	26	20	26	04
		2	CT	19-08-1986	19-08-2006	Gas	28	26	26	26	04

private

1	HARIPUR BMPP	8	D	30-06-1999	30-06-2021	Gas	110	110	85	90	19
2	RPC (Mymensigh)	2x35 2x35	CT CT	20-11-99, Jan 00 Oct 00, Dec 00	20-11-2019 00 oct 2020	Gas Gas	140	140	130	153	17 18
SUBTOTAL (A)							3115	3011	2245	1645	

Hydro =50 Yr CT = 20 Yr, CC = 25 Yr, ST = 30 Yr, D = 20 Yr.

(B) WEST ZONE (Existing)

SL No	Name of the power Station	Unit No.	Unit Type	Commissioning Date (DD/MM/YY	Date of Retirement	Type of Fuel	Installed Capacity	Capability	Generation (MW) on Max. Gen. Day	Generation (MW) on Min. Gen. Day	Remaining Life time (Year) as on 2002
1	2	3	4	5	6	7	8	9	10	11	12
11.	KHULNA	1	ST	25-07-1973	25-07-2003	F.Oil	60	55	48	50	1
		2	ST	07-05-1984	07-05-2014	SKO	110	95	0	0	12
		1	CT	07-06-1980	07-06-2000		28	23	0	0	-
		2	CT	03-06-1980	03-06-2000		28	23	17	0	-
12	BHERAMARA	1	CT	20-04-1976	20-04-1996	HSD	20	18	19	18	-
		2	CT	20-04-1976	20-04-1996	HSD	20	18	19	20	-
		3	CT	19-01-1980	19-01-2000		20	18	18	0	-
13	SAIDPUR	1	D	25-06-1981	25-06-2001	FO/	3.75	2	1.40	1.40	-
		1	CT	17-09-1987	17-09-2007	LDO HSD	20	18	17 50	17 50	05
14	THAKURGAON	1-4	D	06-06-1966	06-06-1986	LDO	6	3	1.40	1.50	-
15.	BARISAL	1-2	D	1975-1980	1995-2000	HSD	2.60	2	0	0	-
		1	CT	05-08-1984	05-08-2004	HSD	20	18	13	17 50	02
		2	CT	04-10-1987	04-10-2007	HSD	20	18	0.0	20	05
16.	RANGPUR	1	CT	25-08-1988	25-08-2008	HSD	20	18	18	18	06
17	BHOLA	1-2	D	08-10-1988	08-10-2008	F.Oil	6	4	1	2	06
18.	BAGHABARI	Ist	CT	04-06-1991	04-06-2011	Gas	71	71	78	76	09

3165 Only Public Sector

Private

1.	KPCL	18	D	02-10-1998	02-10-2022	F.Oil	110	110	116	110	20
2.	BAGHABARI	2	CT	26-06-1999	29-06-2021	Gas	90	90	90	85	19
SUB TOTAL (B) :							655	604	457 3	436.9	-
TOTAL (A+B) :							3770	3615	2702.3	2081.9	-

Source Reference [29].

Table 2.2 shows the location and age of major power plants. Location wise distribution is highly skewed to the Eastern part of the country- mainly due to availability of indigenous fuel- 87.23% of the generation capacity is located in the East of the river Jamuna while the rest is in the west zone.

From table 2.2 we can also see how the BPDB generating capacity will cross their economic life. Already 327MW (10.33%) capacity is past their economic life For obvious reason these units are being operated at a higher cost. Generating units of 471MW (15%) capability will have their economic life expired in next 1-5 years time, units of 173MW (5.5%) capability will retire in 6-10 years, units of 774MW (24.5%) capability will retire in 11-15 years, 430MW (13 6%) in 16-20 years, 630MW(20%) in 21-25 years, 260MW (8.2%) in 26-30 years and 100MW(3.15%) will retire in after 30 years.

It is already seen that a considerable generating capacity of BPDB has either past the economic life or will soon complete their economic life. Naturally the generating units in this category produce less than their installed capacity. According to a study (PSMP-1995) a total of 167MW generating capacity has been lost in different units by February 2000. This non-recoverable capacity is expected to rise in future.

2.2.3. Growth of Generation Capacity of BPDB

A power system has to develop continuously to cope with lost capacity and new demand BPDB system has also grown over the years despite its constraints The growth of generating capacity of BPDB can be seen in figure 2.3. The growth rate between 1989/1990 and 1999/2000 periods is about 47.8%. This may be observed from the figure that there was no addition of generation capacity after 1998/99.

Table 2.3 shows the energy generated by BPDB from 1982-83 till 1999-2000. The table also shows the year-to-year growth of energy generation. Given the perennial short fall in electric power supply it is apparent that growth rate of generation capacity is not sufficient

2.2.4. Installed Capacity, Capability, Maximum Demand Served and Firm Capacity are as below

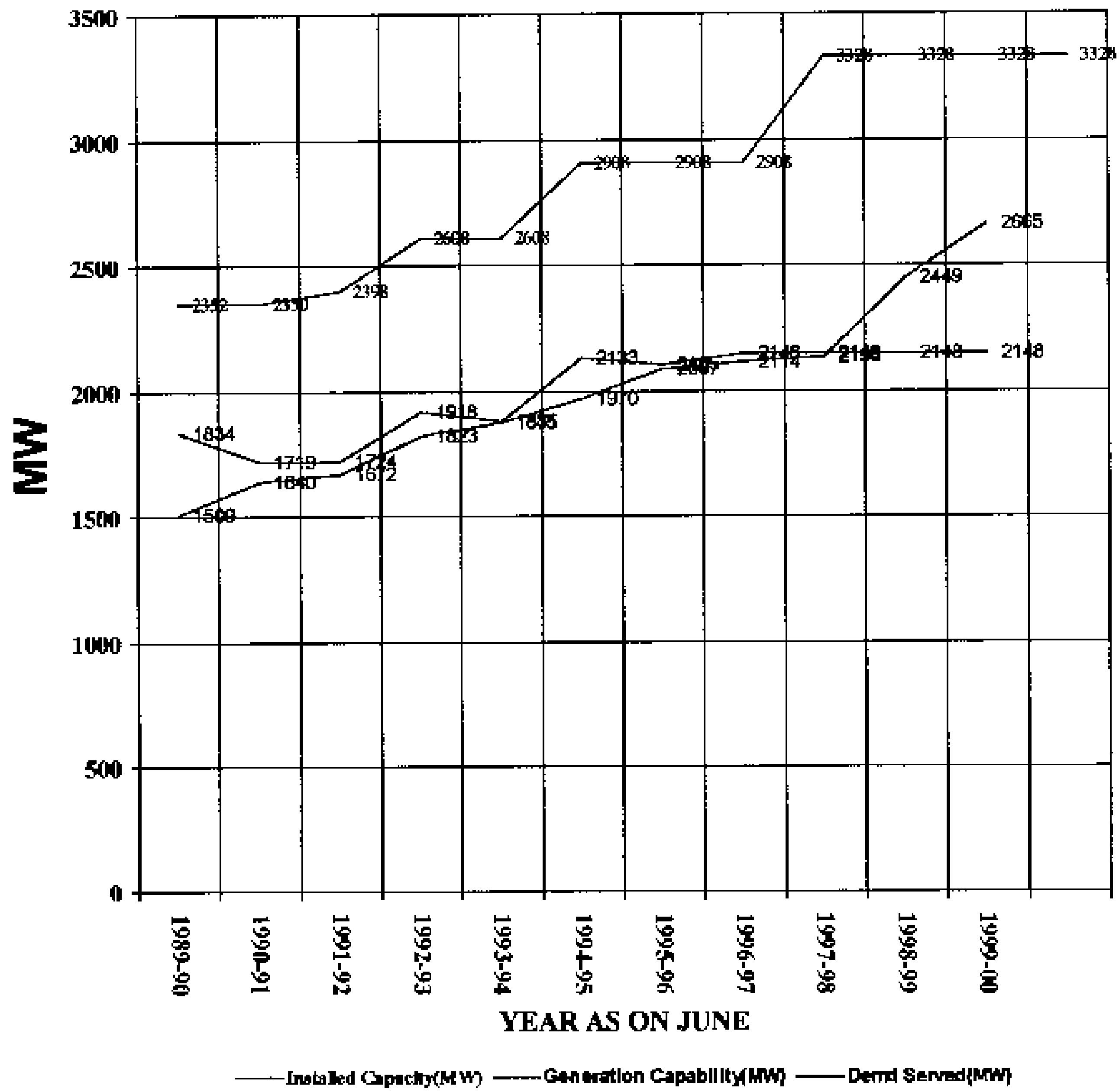


Figure 2.3: Comparison with Installed Capacity, Capability and Demand Served(Except IPPs).

Table 2.3: Year to Year gross energy generation of BPDB.

Year	Gross Energy Generation in GWh			% Increase over the precedin g year	Energy Transfer through East-West Interconnect or	
	East Zone	West Zone	System Total		East to West	West to East
1982-83	2845.6830	586.9890	3432.6720	13 049	341.3200	0 2400
1983-84	3398.1900	568.0000	3966.1900	15.542	519.0400	1.4370
1984-85	3655.8870	872.5460	4528.4330	14.176	477.4100	20.6300
1985-86	3487.9000	1312.3560	4800.2560	6.003	222.4000	106.4300
1986-87	4749.0980	837.8490	5586.9470	16.389	797.8360	10.9070
1987-88	5752.5390	788.8630	6541.4020	17.084	1179.5430	0.0165
1988-89	6533 9443	580.9053	7114.8496	8.766	1550.0000	
1989-90	7400 9835	330.9636	7731.9471	8.673	1956.7845	
1990-91	8125.7950	144.3953	8270 1903	6.961	2314.0668	
1991-92	8499.8960	394.3495	8894 4360	7.746	2213.0000	
1992-93	8582.6860	623.7500	9206.4360	3.510	1919.8870	
1993-94	9129.0381	655.3132	9784.3513	6.277	1980.7620	
1994-95	9885.2798	921.1491	10806.4289	10.446	1954 6160	
1995-96	10734.6225	739.5908	11474 2133	6.180	2215 0160	
1996-97	10804.6985	1052.8935	11857.5920	3.341	1924.1700	
1997-98	11789.0648	1093.3447	12882.4095	8.643	1997.0000	
1998-99	13126.073	746.1321	13872.2052	7.683	2186.000	

Source: Reference[20]

2.2.5. Administrative Arrangement of Power Station

Organizational structure of the power plants of BPDB depends on capacity of power production. Plants with 200MW or more capacity are controlled by Chief Engineer with two or three Superintendent Engineers. These engineers are usually responsible for operation and maintenance of the plant Plant with generating capacity of 40MW or more but less than 200MW are run by a Superintendent Engineer as manager while two executive engineers are in control of operation and maintenance of the plant. It may be mentioned here that each plant has two distinct areas of work. These are operation and maintenance. Operational staffs are doing regular operational job and maintenance staffs are carrying out routine and preventive maintenance.

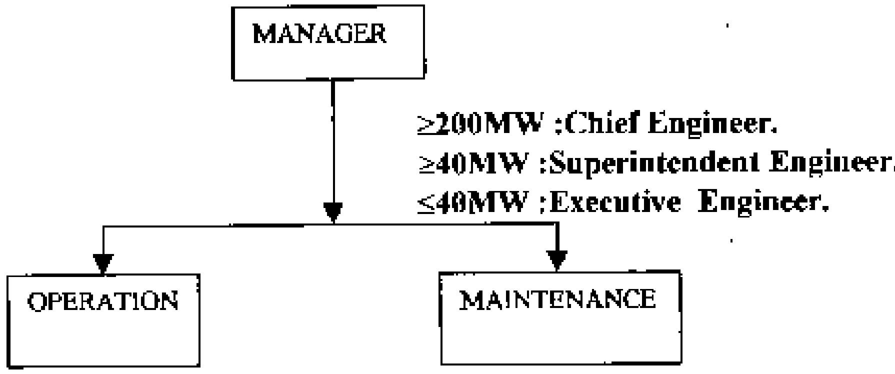


Figure 2.4: Organization of Power Plant.

Figure 2.4 shows the upper tier of the organization chart of power plant of BPDB. The managers of power plants have very limited authority in strategic and certain operational matters. As a result the smooth running of the plant are adversely affected.

Recently BPDB has statted a new administrative arrangement of its power plants. Haripur plant with 100MW capacity has been made a strategic business unit. This administrative authority and responsibility has been largely recast to give more autonomy to the plant management. Figure 2 5 shows the organizational structure of the top tire of Haripur Plant.

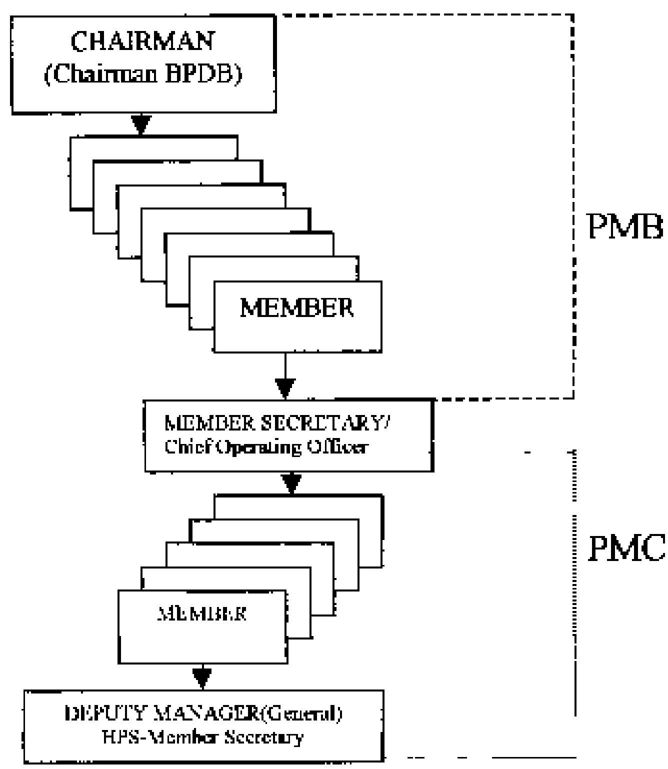


Figure 2.5: Organization of SBU Haripur Power Station.

The Plant Management Board (PMB) consists of 9(nine) members. The Chairman of BPDB is the Chairman and Manager of Haripur Power Station is the Member Secretary of this Board. The Management Board is the apex body responsible for management of Haripur

Power Station. The Board is primarily responsible for strategic management to ensure smooth generation of power by efficient utilization of the facilities.

The Plant Management Committee consists of 6(six) members. The Manager of Haripur Power station is the Chief Operating Officer and Deputy Manager (General) of Haripur Power Station is the Member Secretary of this Committee. The PMC will be responsible to assist the Manager and the board to ensure smooth operation and maintenance of the Power Station.

PMB is empowered to exercise the same financial and administrative power as that of BPDB, while the Plant Management Committee of the Station will exercise most of the total financial and administrative powers of PMB in respect of material, equipment, machinery, service and human resources. The delegation of the above authorities has greatly improved the operational efficiency of the plant. Noticeable improvements were observed [11] in one year. The overall performance and achievement of HPS during the first year of its operation as SBU is quite satisfactory and appreciable. The main achievements may be summarized as.

(a) The employees are motivated to face the challenges of the reform.

(b) Discipline has been established everywhere.

(c) Shortening the time required for procurement of foreign spare to a greater extent.

(d) Analysis of past troubles and taking necessary countermeasures.

(e) Preparation of short, medium and long-term maintenance plans.

(f) Imparting on -job training for all categories of the employees

(g) Implementation of all types of routine, preventive, emergency & schedule maintenance including CI(Combustion Inspection), HGPI(Hot Gas Path Inspection), and MOH as per manufacturer's schedule without the assistance of foreign experts

(h) Practicing of total quality management in the stations.

As a result the operational performance of the plant has attained its targeted goals as shown in Table 2.4.

Table 2.4: Operational performance of HPS

Parameter	Target	Achievement
Generation	442 04GWh	488.88GWh
Plant Availability	86.05%	90%
Reliability	98.42%	98.18%
Efficiency	23%	23%

2.3. Transmission and Distribution Grid of BPDB

BPDB owned and operated the transmission and distribution system until 1996. In July 1997 Power Grid Company of Bangladesh (PGCB) was created to own and operated the transmission system.PGCB is a limited company with a board of directors. A part (30%) of the transmission system was handed over to PGCB from BPDB. Eventually BPDB and DESA will hand over all 230KV, 132KV and 66KV lines and terminal equipment and assets to PGCB. The administration of PGCB and BPDB are still strongly linked. As such discussion on transmission and distribution of electricity in this section is presented assuming BPDB owning the system.

2.3.1. Description of the Transmission and Distribution Network

Table 2.5, 2.6, 2.7, 2.8, 2.9 and 2.10 presents the physical and technical parameter of different components of the transmission and distribution system of BPDB.

Table 2.5: 230 KV Existing Grid lines.

Sl. No.	Name	Length in route (km)	Length in Ckt. km	No of Ckt	Conductor brand Name	Conductor Size
1	East- West Electrical Interconnector	179	358	Double	Mallard	795MCM
2	Tongi-Ghorasal	27	54	Double	Mallard	795MCM
3	Ashuganj-Ghorasal	44	88	Double	Mallard	795MCM
4	Raujan-Hathazari	22	44	Double		Twin 300 sq.m.m
5	Ashuganj-Comilla	79	158	Double	Finch	1113MCM
6	Ghorasal-Haripur-Hasnabad	60	120	Double	Twin Mallard	795MCM
7	Ishurdi-Bharamara	8	16	Double	Mallard	795MCM
8	Comilla-Hathazari	151	302	Double	Twin Mallard	2X795MCM
	Total	570	1140			

Source: Reference [20].

Table 2.6: 132 KV Existing Grid lines.

Sl. No	Name	Length in route (km)	Length in Ckt. km	No. of Ckt.	Conductor brand Name	Conductor Size
1	Siddhirganj-Shahjibazar	138	276	Double	Grosbeak	635MCM
2	Kaptai-Siddhirganj	273	546	Double	Grosbeak	635MCM
3	Kulshi-Halishahar	13	13	Single	Grosbeak	635MCM
4	Shahjibazar-Chatak	150	300	Double	Grosbeak	635MCM
5	Comilla North-Chandpur	70	70	Single	Linnet+ Grosbeak	
6	Comilla North-Comilla South	16	32	Double	Grosbeak	635MCM
7	Ashuganj-Jamalpur	166	166	Single	Grosbeak	635MCM
8	Madanhat-Sikalbaha	13	26	Double	Grosbeak	635MCM
9	Sikalbaha-Dohazari	35	70	Double	Grosbeak	635MCM
10	Sikalbaha-Halishar	13	13	Single	AAAC	804 sq.m.m
11	Kabirpur-Tangail	51	73	Single	Grosbeak	635MCM
12	Kulshi-Baraulia	13	13	Single	Grosbeak	635MCM
13	Madanhat-Kulshi	13	13	Single	Grosbeak	635MCM
14	Madanhat-Kulshi	13	13	Single	Grosbeak	635MCM
15	Kaptai-Baroaulia	58	116	Double	Grosbeak	635MCM
16	Dohazari-Cox's Bazar	88	88	Single	Grosbeak	635MCM
17	Feni-Chowmuhani	32	32	Single	Grosbeak	635MCM
18	Mymensingh-Netrokona	34	34	Single	Grosbeak	635MCM
19	Goalpara-Ishurdi	169	338	Double	HAWK	477MCM
20	Ishurdi-Bogra	106	212	Double	HAWK	477MCM
21	Bogra-Saidpur	140	280	Double	HAWK	477MCM
22	Saidpur-Thakurgaon	64	128	Double	HAWK	477MCM
23	Goalpara-Bagerhat-Barisal	109	109	Single	HAWK	477MCM
24	Bagerhat-Mongla	31	31	Single	HAWK	477MCM
25	Barisal-Patuakhali	37	37	Single	Grosbeak	635MCM
26	Kawkhali-Bhandaria	8	8	Single	HAWK	477MCM
27	Bheramara-Bhandaria	225	450	Double	HAWK	477MCM
28	Rajshahi-Natore	40	40	Single	HAWK	477MCM
29	Ishurdi-Shahjadpur	73	73	Single	Grosbeak	635MCM
30	Bogra-Serajganj	66	132	Double	Grosbeak	635MCM
31	Serajganj-Shahjadpur	34	68	Double	Grosbeak	635MCM
32	Rajshahi-Nawabganj	47	94	Double	Grosbeak	635MCM
33	Ishurdi-Pabna	16	16	Single	Grosbeak	635MCM
34	Pabna-Shahjadpur	40	40	Single	Grosbeak	635MCM
35	Rangpur-Lalmonirhat	38	38	Single	Grosbeak	635MCM
36	Bogra-Noagaon	52	52	Single	Grosbeak	635MCM
37	Comilla(s)-Baraulia	150	150	Single	Grosbeak	635MCM
	Total	2634	4190			

Source: Reference [20].

Table 2.7: 66 KV Existing Grid Lines.

Sl. No.	Name	Length in route (km)	Length in Ckt. km	No. of Ckt.	Conductor brand Name	Conductor Size
1	Rajshahi-Ishurdi-Pabna-Ullapara-Serajganj	167	176	Single		
	Total	167	167			

Source: Reference [20].

The salient feature of the grid sub stations for 230KV and 132KV are as below.

Table 2.8: Existing 230KV Substations.

Sl. No.	Name of the Grid Sub Station	Transformer capacity (MVA)
1.	Raojan(P/S)	-
2	Hathazari	3x150
3.	Comilla (N)	1x225 (3x75)
4.	Ashuganj	2x150
5	Ghorasal	2x125
6.	Tongi	2x225 (7x75*)
7.	Haripur	2x225(7x75*)
8.	Hasnabad	2x225(7x75*)
9	Ishurdi	3x225(9x75)
	Total	3250

Source. Reference [20].

Table 2.9: Existing 132 KV Grid Sub Stations (East).

Sl No	Name of the Grid Sub Station	Transformer capacity (MVA)
1	Siddhirgnj	2x50/83 1x25/33
2	Maniknagor	Switching Station
3	Hasnabad	3x35/50/55
4	Tongi	1x50/75 2x25/41
5	Kabirpur	2x25/41
6	Ghorashal	2x50
7	Ashuganj	2x15/25
8	Baraulia	1x28/40
9	Chandpur	2x15/20
10	Chandroghona	2x10/13.33
11	Chatak	2x15/20
12	Comilla (N)	1x40
13	Comilla (S)	2x25/41
14	Cox's Bazar	1x16/20
15	Dohazari	2x28/40
16	Fenchuganj	1x15/19 93
17	Fenchuganj P/S	Switching Station
18	Feni	2x15/20
19	Halisahar	2x44.1/63
20	Hathazari	2x44 1/63
21	Jamalpur	2x25/41
22	Kaptai	1x15/20
23	Kishorganj	2x15/20
24	Hulshi	2x44.1/63
25	Madanhat	1x25/41.67
26	Mymensingh	2x25/41
27	Shahjibazar	1x25

28	Sikalbaha	2x25/41.677
29	Sreemongol	2x15/20
30	Sylhet	2x25/41
31	Tangail	2x25/41
32	Netrokona	2x15/20
33	Chowmohoni	2x25/41
	Total	2376 27

Source: Reference [20].

Table 2.10; Existing 132 KV Grid Sub Station (West).

Sl No	Name of the Grid Sub Station	Transformer capacity (MVA)
1	Bagerhat	2x10 31 33
2	Barisal	2x25/41
3	Dheramara	1x12 5/16 67
4	Bogura	2x25/41
5	Bottail	2x25/41
6	Faridpur	2x15/20
7	Goalpara	2x12 5/16.67
8	Ishurdi	2x15/20 1x2.5/16.67
9	Jessore	2x40
10	Jhenaidah	2x20
11	Khulna (C)	3x48/64
12	Madaripur	2x10/13.33
13	Mongla	2x10/13.33
14	Natore	2x15/20
15	Noapara	2x20
16	Palashbari	2/15/20
17	Purbosayedpur	2x12.5/16 67
18	Rajshahi	1x25/33
19	Rangpur	2x25/41
20	Sayedpur	2x25/41
21	Shahjadpur	1x15/20
22	Thakurgaon	1x12 5/16 67 1x15/20 1x10/13 33
23	Pabna	2x25/41
24	Nawabganj	2x15/20
25	Serajganj	2x15/20
26	Lalmonirhat	2x15/20
27	Naogaon	2x25/41
28	Patuakhali	2x15/20
29	Bhandaria	1x10/13.33
	Total	1575.66

Source Reference [20]

The total length of distribution lines comprising 33KV, 11KV, and 11/0.4KV lines stood at 39363 km at the end of FY 1999-2000 compared to 38658km at the end of FY 1998-1999. A total of 705km of distribution lines were added for the increment of 7.18% consumer. The system loss of BPDB's own distribution lines are 27.86%.

2.3.2. Administrative Arrangement of the Transmission and Distribution Grid

BPDB owned transmission system is at present maintained and monitored by a chief engineer Total transmission system is divided into several circles. One superintendent engineer is the head of each circle Two or three executive engineers' assists the head of that circle These executive engineers are the heads of each division. Few sub-stations and included grid lines are maintained and monitored by one divisional head. One Sub-divisional engineer is in charge of a sub-station. The upper tier of the transmission system is shown in the figure 2.6.

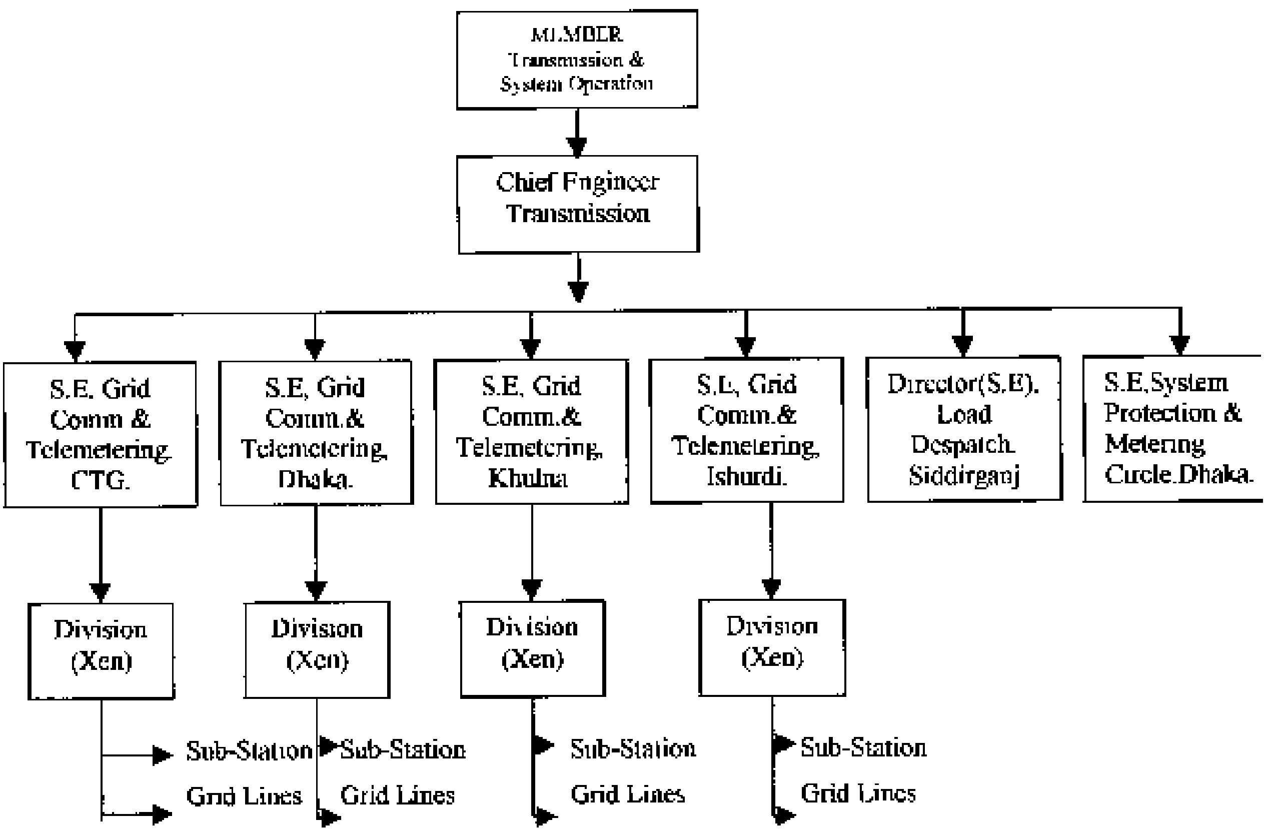


Figure 2.6: Organization chart of Transmission System.

A new transmission company named Power Grid Company of Bangladesh (PGCB) is in operation with part stake from private sector. The PGCB has two-apex body of management. These are board of directors and management. Chairman BPDB is the chairman of the board of directors. This board consists of 9(nine) member including chairman and three members from PGCB and others from out side. The management is the executive body for operational purpose where Managing Director is the head of the management Others are Director (Technical) and Director (Finance) These directors are part of the board. Figure 2 7 shows the upper tire organizational arrangement of PGCB.

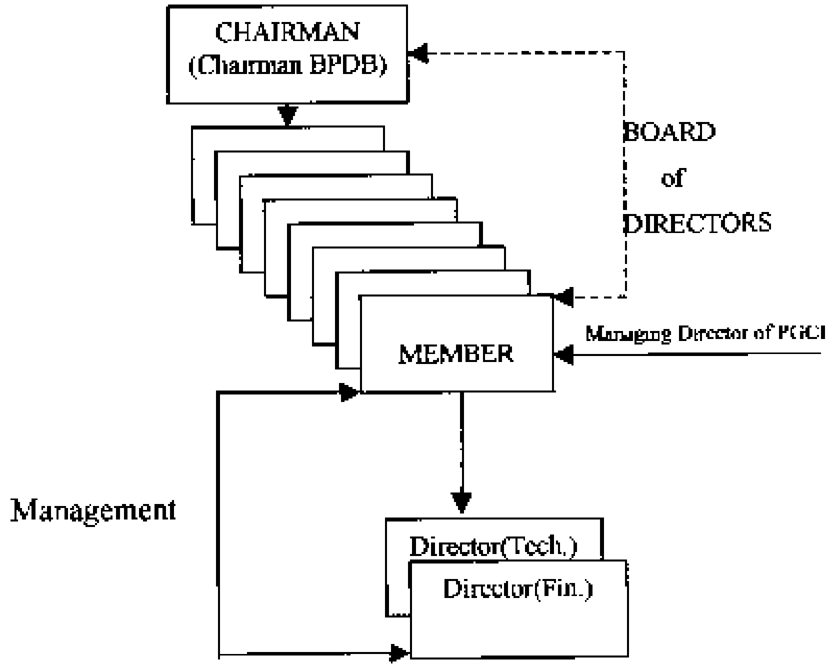


Figure 2.7: Upper Organizational arrangement of PGCB.

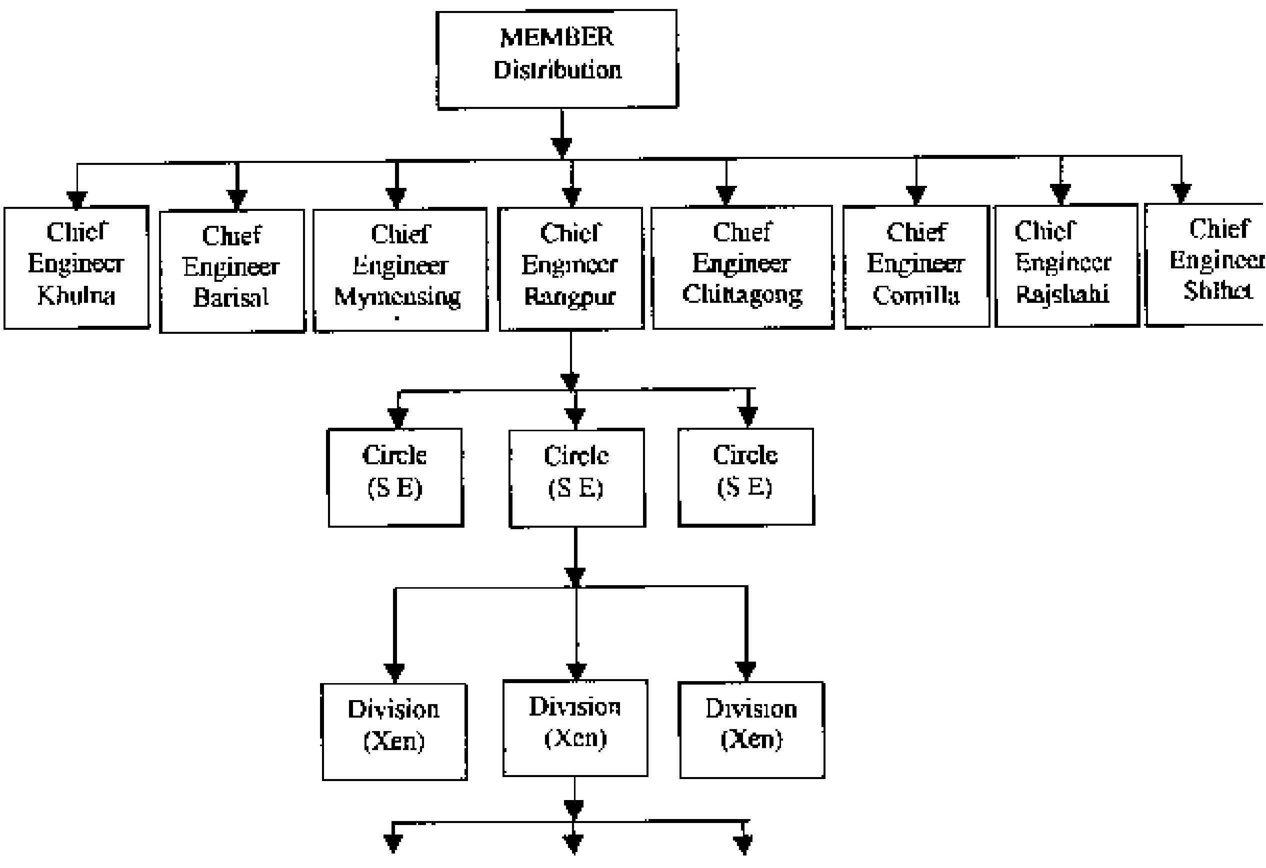
As per the agreement with GOB, PGCB will own and operate the whole transmission system after December 2002. BPDB has started handing over the transmission assets to PGCB. The present state of ownership is shown in Table 2.11.

Table 2.11: Handed over transmission assets to PGCB.

Type of Transmission	Length/Capacity	Sectors
230KV Transmission Line	479.5km	Hathazari-Comilla-Ashuganj-Ghorasal-Ishwardi,Ghorashal-Tongi
132KV Transmission Line	653km	Hathazari-Feni-Comilla-Ashuganj-Kishorganj-Mymensingh-Jamalpur,Mymensingh-Netrokona,Comilla-Chandpur,Feni-Chowmuhani,Comilla-Haripur-Siddirgonj.
123/33KV Sub-Station	983MVA	within transmission area

PGCB has taken over the main transmission line (230KV) from Chittagong to Ishwardi, which is about 61 4% of total 230KV existing lines. It has also taken over one major feeder to Dhaka city – the top most consumption center of the country As to 132KV transmission line, PGCB has taken over the most of the network in the eastern part of the country except Dhaka city and greater Sylhet area.

Smooth distribution and control is the part of power management. Considering this view whole distribution network has been divided into eight zones depending on geographical area of Bangladesh Chief engineer is the head of each zone. The Chief Engineers of the zones are under the supervision and control of Member of BPDB in charge of Distribution. At present the zones are Sylhet, Comilla, Rajshahi, Chittagong, Rangpur, Mymensing, Khulna and Barisal. Depending on coverage of a zone, two or three Superintendent Engineer assists Chief Engineer. Figure 2.8 shows the organizational arrangement of the distribution system of BPDB.



*ESU= Electric Supply Unit, O&M= Operation and Maintenance, Con Complain Consumers Complain,

Figure 2.8: Organization Chart of Distribution System.

Due to years of mismanagement resulting in system loss, BPDB has taken up a new concept of distribution management Two pilot scale projects were taken in two Divisions in Mymensingh termed as Strategic Business Unit (SBU). SBU covers one Division. The basic philosophy of SBU concept is to deliver quality service to the consumers at the existing price. To make the unit financially viable and run it efficiently SBU was conceived in such way so that each and every output of SBU activity can be measured as per standard set of indicators and at the same time quality of service and product can be compared with standard specification. An incentive and punishment system is also formulated to motivate the people working in the SBUs. A task force comprising executives from the Division as well executives from the Power Cell will manage the strategic matters of the unit.

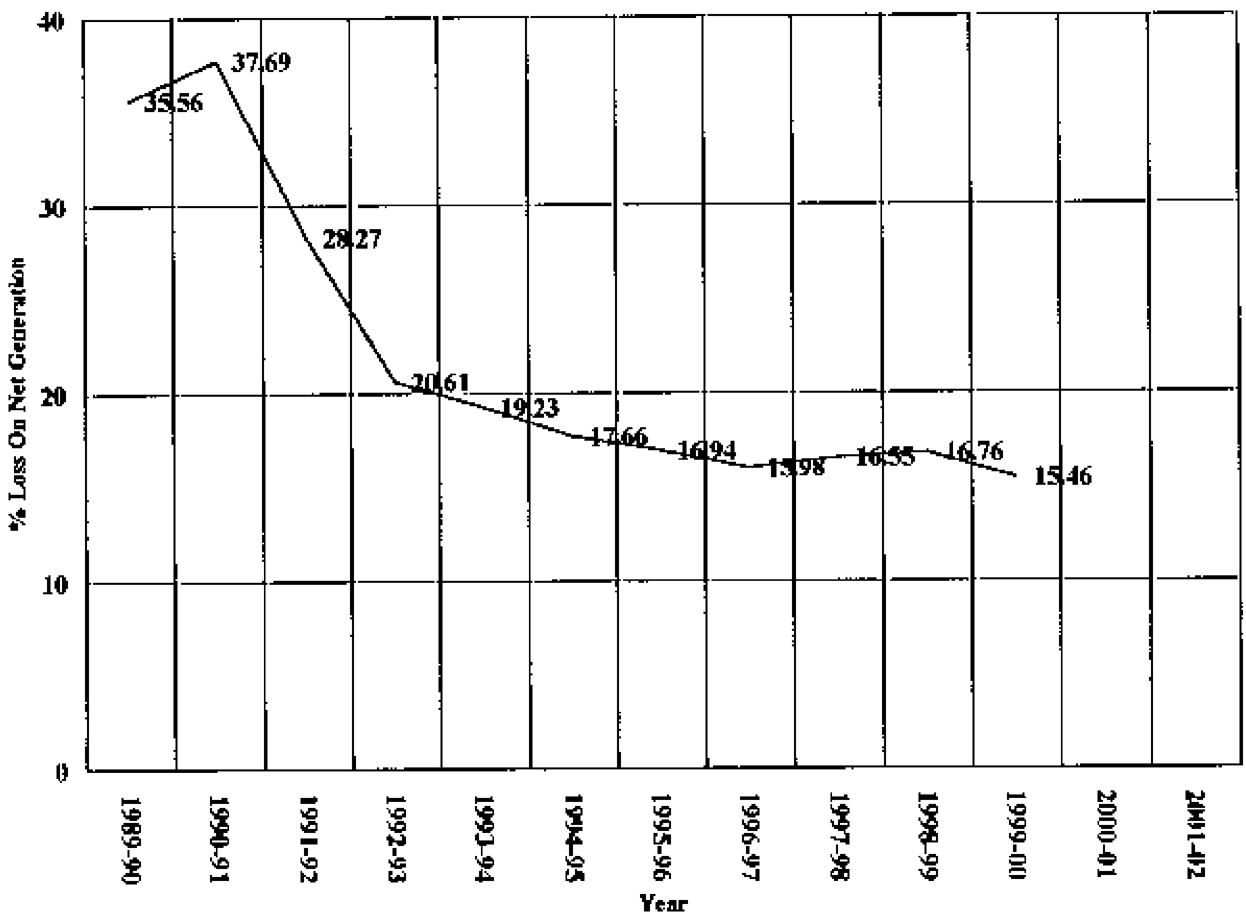
After the first phase (first 6 month) the SBUs achieved quite encouraging results These are shown in Table 2 12.

Table 2.12: Achievement in the SBUs.

Parameter	Jamalpur SBU	Sherpur SBU
Demand Saved	0.872MW	1 00Mw
Extra Revenue Added	TK64.24 lac	Tk32 94 lac
Distribution loss		
Reduce to	15.01% from 29.85%	17 78% from 33.96%
Collection/Import ratio		
Improve from	54% to 100%	57 76% to 86.51%

2.4. System Loss

The System loss in electricity is an unpleasant and acute problem in Bangladesh. This is an outcome from the mismanagement since long. Two basic system losses are technical loss and non-technical loss. The combined net system loss of BPDB and DESA has been around 36% and overall collection has been around 80% of billing (FY 1999-00) This means that the overall collection to generation ratio has been only around 69%. The existing system loss in BPDB is shown in the figure 2.6. It can be seen that the loss has come down over the years and leveled off at around 16% for last few years. Different factors that contribute to system loss are described next



Source- Reference [20].

Figure 2.9: System loss on Net generation.

2.4.1. Technical Losses

Technical losses are caused due to inherent resistance of metal of line, Transformer, Isolators, Connectors and other electric equipment. This cannot be made zero due to metal characteristics but it can be kept at minimum level. The causes of technical losses and its probable reduction measures are given below:

Long Length of Feeder.

Expansion of distribution lines without any technical design feasibility and in unplanned way due to customer demand, and political pressure has resulted in inefficient system. Some of the feeder of 11KV are more than 150Km long and lacks alternative point of power supply.

Renovation of Feeders.

In urban areas power demand increases tremendously but the conductor size remain old and inadequate. This cause high technical losses. Some time linemen use G.I. wire due to non-availability of correct wire which adds distribution loss tremendously.

Improper Distribution Transformers.

The small size transformer available now is 25KVA but some village and irrigation pump require 10KVA transformer or less which adds technical loss. Due to fast growing demand in urban area the transformer gets easily overloaded. This also results in technical losses.

Low Power Factor.

Low power factor on the distribution system is the major cause of technical losses. Irrigation pumps, Induction motors etc in the industry, electric fans and air conditioners contribute to low power factor due to high reactance of motors. The generators, transmission and distribution lines also contribute reactive power.

Connections, Isolators, Dropout Fuses, Consumers Service.

Most of the line staff of BPDB has shallow knowledge or no knowledge about technology of electric supply system and proper utilization of this item, which led to poor workmanship. This poor work causes technical losses.

Metering.

There may be a little or a marginal loss in metering but slow operation of meter causes losses. Low quality single phase meters manufactured in some Countries runs slower after few years while good quality meters from South Korea and Japan have no such problem. These low quality meters run 3-5% slower after a few years and this results in considerable loss of revenue

2.4.2. Non-Technical Losses

Non-Technical losses include pilferage of electricity, administrative errors in metering system, mismanagement in distribution sector, meter tempering, low professionalism, disloyal employ starting from lower level to top of the pyramid, fraudulent practice of the customer These losses can be made zero if the bonafide loyal management system can be improved

2.5. Cost and Revenue

Financially BPDB is incurring loss. The operating cost and revenue collection in 1999-2000 as in Table 2 13 shows the non-operating expenses constitute a considerable part (19%) of the total expenditure and is the cause of operating loss of BPDB.

Table 2.13 : Operating Cost and Revenue Collection in 1999-2000

Operational Revenue	
Electricity Sales	: TK. 27,358 62 million.
Other operating income	: TK. 503.08 million
Total operating revenue	: TK. 27,861.70 million.
Operating expenses	
Fuel cost	: TK 9,143 82 million.
Electricity purchase from IPP	: TK 3,639.47 million.
Depreciation	: TK 7,002 26 million.
Repair and Maintenance	: TK 2,411 57 million.
Personnel Expenses	: TK 2,336.95 million.
Office and Administrative Expenses	: TK 1,146.76 million.
Assets Insurance Fund	TK 15.00 million.
Transmission Charge paid to PGCB	: TK 12.05 million.
Total Operating Expenses	: TK 25,707.88 million.
Operating Income	TK 2,153.82 million.
Non- Operating Expenses.	
Interest on Loans	. TK 3,076 98 million.
Loss due to Exchange Rate Fluctuation	: TK 3,021.02 million.
Net Non- Operating Expenses	: TK 6,098 million.
Net loss	: TK. 3,944.18 million.

Source- Reference [20]

Table 2.14 shows billing and revenue collection of BPDB for last 10 years. The figures in the last column of the table suggest that BPDB fails to collect its due revenue. From the table it can be seen that on the average 12% of the billing amount is not collected. Had it been collected timely, revenue collection in 1999/2000 would have increased by Tk. 3800million, which is close to the operational loss of Tk. 3944 million

Table 2.14: Billing Rate and Revenue Collection

Year	Billing Rate TK/Kwh	Gross Billing Million Taka	Gross Collec Million Taka	Collec. as % of Billing	Collection./ Net gen. %
1991-92	2.00	12220.56	10484.71	85.80%	62.41%
1992-93	1.90	13295.91	12080.68	90.86%	73.10%
1993-94	1.89	14245.03	11977.10	84.08%	68.84%
1994-95	1.87	15904.83	14271.75	89.73%	74.92%
1995-96	1.87	17010.70	15582.47	91.60%	77.06%
1996-97	1.96	18740.22	16266 11	86.80%	73 92%
1997-98	2.07	21204.72	17388.91	82.00%	69.05%
1998-99	2.08	23862 43	16475.21	69 04%	58.05%
1999-00	2.20	27774.35	22894.46	82.43%	70.70%
2000-01	2 25				

Source- Reference [20].

CHAPTER-03

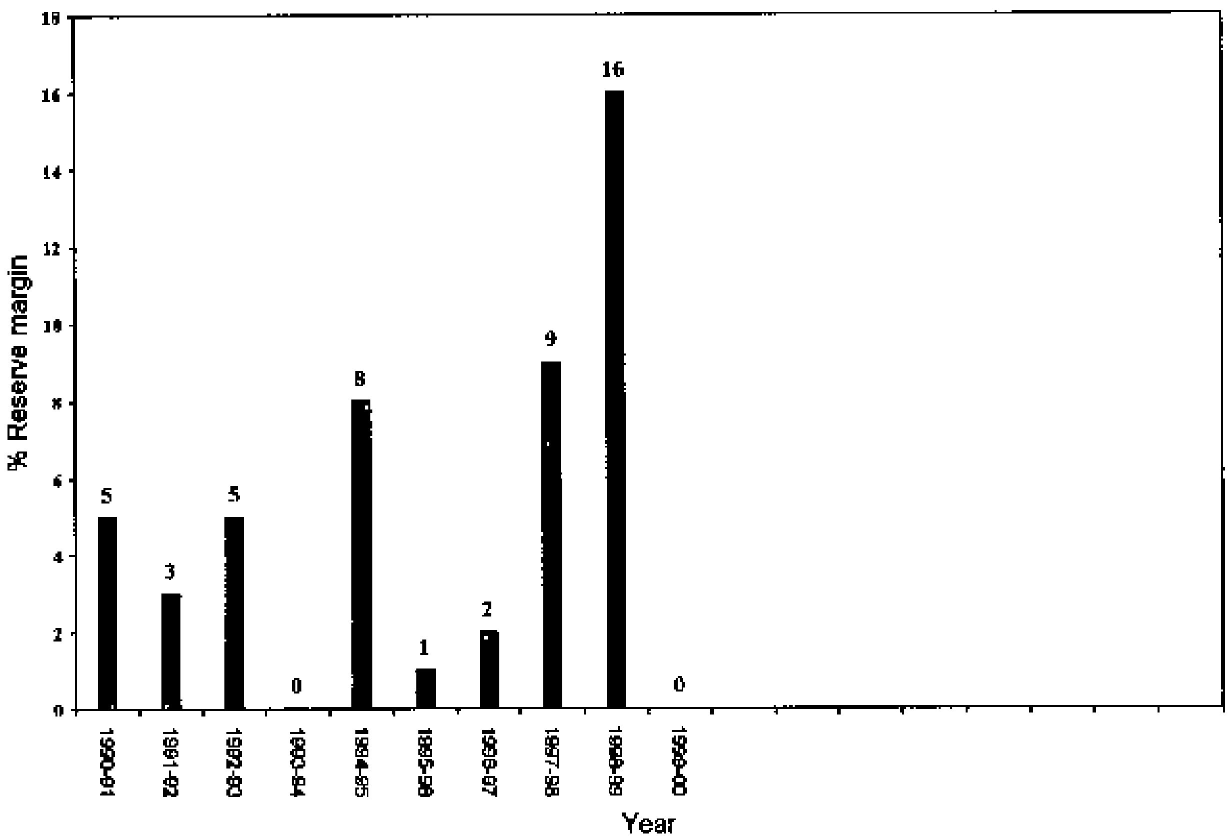
IPPs (Independent Power Producers) and Their Operation in Power Sector

CHAPTER-03

IPPs (Independent Power Producers) and Their Operation in Power Sector

3.1. Brief Background

After Liberation war the damaged power installations were rehabilitated with the finance and help of multilateral donors till 1990. But the foreign investors were not in favor of financing in Energy Sector of Bangladesh [13,25] due to its mismanagement and huge



Source- Reference [20]

Figure-3.1: Year wise reserve margin.

non-technical losses. However, development in industrial and commercial sector continued resulting in increased demand of electricity. Naturally the gap between the supply and demand widened leading to lower and lower reserve margin as can be seen in Figure 3.1. The power outage was a routine matter due to low reserve margin. According to the power system Master Plan (PSMP-1995) an investment of US $ 6.6 billion for the power sector would have been necessary to meet the demand until 2010. The Government of Bangladesh realized that this huge investment during this period far exceed the capacity of the public sector as donors withdrew their financing To meet the balance between the demand and supply only private sector could come with necessary fund in shorter period. With this realization government encouraged private participation to meet the growing demand. In this respect GOB formulated a private sector power generation policy in 1996 and the first private sector power plant came into operation in 12 September 1998.

3.2. Description of IPPs

Starting from 1998 so far 685MW[2,3] power has been added from the private sector and 960MW more is in the construction stage. Table 3.1 presents the location, capacity and states of the IPPs in the country. It can be seen from the table that the total private power generation in the east zone will be 1515MW(92%) and only 130MW(8%) will be generated from west zone The main reason for this unbalanced location is the availability of cheap natural gas in the East.

Among the total committed generation capability in private sector, 940MW(57%) will be by combined cycle technology, the most efficient technology in power generation. Typical efficiency of combined cycle plant is about 45% The rest is produced by gas turbine (9%) and gas/diesel engine (34%) technology.

Almost all the plants were contracted for fifteen year except for AES Meghnaghat and AES Haripur after the date of full commercial operation. The contract year for AES Meghnaghat and AES Haripur is 22 years. After the agreed period renewal will be decided by GOB. IPPs under REB will not contribute to national grid directly. They will fulfill the demand of PBSs, so that PBSs become somewhat independent of BPDB

Table-3.1: Description of IPPs with tariff and capability.

Sl No.	IPPs	Site/Location	Contracted Capacity in MW	Type of Plant	Present Status
1.	Khulna Power Company Ltd (KPCL)	Goalpara. Khulna	110	Gas, Diesel (GD) Engine (19x6.5 MW) Operating with H F O	In Operation
2	Westmont Power Bangladesh Ltd.	Baghabari, Sirajgonj	130	C.C (2x 45 MW G.T.) (1x 40 MW S.T)	90 MW G T in Operation
3	NEPC Consortium Power Ltd.	Haripur, Narayangonj	110	Gas. Diesel (GD) Engine Operating (8x15 MW) with Gas	In operation
4.	AES Haripur private Ltd.	Haripur	360	C C. (1x235 MW G.T.) (1x125 MW S T)	235 MW G T under Commissionin g C.C. under construction
5	AES Meghnaghat Ltd.	Meghnaghat	450	C.C (2x150 MW G.T.) (1x150 MW S.T)	Under construction
6.	AES Haripur private Ltd.	Haripur	235		In Operation
7.	*RPCL	Shambhuganj Mymensingh	140	G.T (4x 35 MW G.T)	In Operation
8.	REB	Comilla, N.ganj. Tongi	30 (3 x 10MW Capacity)		In Operation
9.	REB		80 (8x 10MW Capacity)		Under Construction
		Total	1645		

[Source: IPP Cell in BPDB]

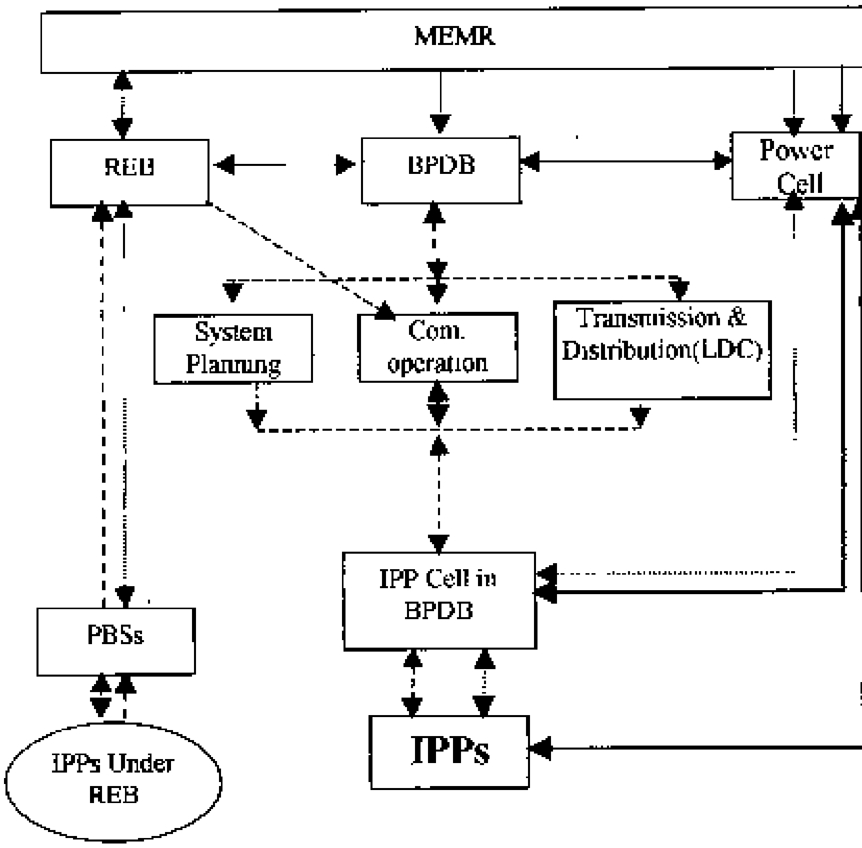
(* Mixed sector IPP 28% share owned by REB and 72% by PBSs)

3.3. Relationship of IPPs with Public Sector

At present the Ministry of Energy and Mineral Resource controls the Energy Sector. Under MEMR several organizations work for electricity such as BPDB, DESA, DESCO, PGCB, IPP. As BPDB buys power from IPPs, they have most interaction with BPDB. IPPs interact with Power Cell, the think tank of the ministry during contract formation, negotiation, finalization and during implementation of the contract.

A section within the Commercial Operation division of BPDB called IPP Cell deal with the IPPs on day-to-day basis. The cell checks the bill submitted by the IPPs based on the data from Commercial Operation, System Planning and LDC in Transmission and Distribution Sector of BPDB. After vetting the bill, IPP Cell forwards it to the invoice committee in commercial operation division. The invoice committee composed of very senior officers in commercial operation scrutinizes the bill and forwards it to director finance and member finance for their approval. After getting the approval from them the chairman of BPDB approves the invoice for final payment.

Figure 3.2 schematically shows the relationship of IPPs with Power Cell and different components of BPDB. IPPs operating under PBSs of REB only deal with the respective PBS, as they are autonomous bodies within REB. As regards operation planning LDC of BPDB places demand to IPPs with a information to System Planning and IPP Cell.



[Source: IPP Cell in BPDB]

Figure-3.2: Relationship and Administrative link with public and private sector.

3.4. Important Contract Issues

The IPPs operating in Bangladesh can be grouped into two categories. One group of IPPs have high tariff rate while another group has low tariff rate. This section is based on the contracts of, a high tariff IPP and a low tariff IPP. BPDB is operating with the IPPs based on the agreed terms and contracts. Major issues related to operation and management of IPPs vis-a-vis BPDB is noted below.

3.4.1. Higher Tariff Rate IPPs[8]

The company shall be responsible for generating and stepping up of power to the 132 KV level and the company will arrange interconnection between the plant and nearest 132 KV grid sub-station through a 132 KV transmission line/cable. The IPPs shall be responsible for all safety protection for the plant and interconnection line protection. This cost shall be reimbursed by BPDB relating to interconnection facilities under agreed terms and condition.

IPPs shall be responsible for design, furnish, construction and install in accordance with agreed conditions.

The plant commercial operation tests shall be carried out as per the agreement. Upon satisfactory completion of the plant commercial operation tests, the IPP shall notify BPDB that the plant commercial operation date shall occur on the following day. The IPPs shall also procure a certificate of an independent engineer approved by BPDB, certifying that the plant's testing has been completed and that the plant is available for full commercial operation and shall provide a copy of such certificate to BPDB by no later than seven (7) days after the company receive such certificate.

BPDB shall pay to the IPPs the tariff charge in accordance with the agreement for all Net Electric Output (NEO) supplied to the delivery point after the commissioning date and prior to the full commercial operation date.

In the event IPP is unable to undertake the commissioning and/or testing of the plant in accordance with the programs and procedures as per the agreement due to failure by BPDB to issue sufficient dispatch instructions for the plant or accept power, BPDB shall pay liquidated damages to the IPPs at 50% plant factor as capacity payment.

BPDB shall issue dispatch instruction consistent with and within the functional specification. Outage & maintenance has to be taken with prior notice.

A capacity test shall be carried out at least once in a year as per the agreed schedule or if BPDB reasonably believes that the current guaranteed capacity (GC) does not accurately reflect the capacity available to BPDB's system, BPDB shall have the right to request one additional capacity test of the plant.

Between commissioning date and full commercial operation date dispatch shall be at the discretion of the IPPs.

IPPs shall have a fuel stock to operate the plant at the current guaranteed capacity (GC) for a continuous period of 30 (Thirty) days at plant factor (PF) of 80%. If BPDB is unable to supply gas, then the IPPs shall be under obligation to continue the operation using liquid fuel. In this event the FT (Fuel Tariff) portion of the tariff charges shall be calculated as per the fuel chart based on liquid fuel.

Electricity sold and purchased shall be calculated as per the reading from delivery point and all transmission loss before the delivery point shall be for the IPPs account and all transmission losses beyond the delivery point (DP) shall be for BPDB's account.

The IPPs shall within thirty (30) days of the end of each month prepare and issue to BPDB an invoice in respect of the tariff charges due from BPDB for that month. Tariff charge payable by BPDB here under shall be due and payable within forty-five (45) days after the date of delivery of the invoice. After the due date BPDB shall pay the IPPs with simple interest.

Invoice amounts due to the IPPs will be paid by the BPDB in Bangladeshi Taka at the exchange rate for purchase of US dollars as on the business day immediately preceding the date on which payment is made plus commissions and other conversion fees payable by the company for conversion of such amount to US Dollars.

BPDB may not terminate this agreement as a result of a IPPs event of default as per agreement without first giving a copy of any notices required to be given to the IPPs.

In the event that upon completion of the plant commercial operation's test (a) the guaranteed capacity (GC) is less than 82% of installed capacity then the IPPs shall pay BPDB at the rate of US Dollars 20,000 for each MW by which the guaranteed capacity (GC) is less than 82% of installed capacity but will not exceed
5 MW or (b) If the guaranteed capacity is less than 77% of the installed capacity then BPDB shall have the right to terminate the agreement and forfeit the performance bond forthwith.

If BPDB fails to buy minimum guaranteed capacity (GC) then the minimum guaranteed payment (payment for 50% PF) payable to the IPPs in a month will be calculated as per this agreement. This payment will not include fuel tariff.

If the Force Majure event occurs, resulting in damage to, or other adverse effect on, the Plant, the IPPs as soon as reasonably practicable shall submit to BPDB a good faith estimate of the cost of restoration and a proposed restoration schedule. If the parties cannot agree on such cost and schedule within thirty (30) days of such submittal, than the matter shall be referred to an expert for settlement. If this agreement is not terminated by BPDB as per the compensation clause, the IPPs shall be entitled to receive recovery allowance payments from BPDB to recover fully the difference between the restoration costs incurred and any insurance proceeds received by the IPPs as a result of the occurrence of such Force Majeure

As per the agreement the tariff will be in two parts, one is energy payment and the other is capacity payment depending on the Net Electric Output (NEO) at the delivery point. Each IPP have a separate tariff rate depending on plant factor (PF) and fuel burnt. One IPP follows the following formula. These are -

Operation and Maintenance Tariff(OMT).

As per the agreement the 99% of NEO will be calculated in dollar and then it will be converted to Taka and 1% will be directly calculated in Taka. Fuel tariff will be calculated as per the rate in PPA (Power Purchase Agreement). The total tariff rate will be the sum of OMT and FT [8].

OMT has two parts:

Part 1: Dollar Component in Taka.

OMT

=(OMT at tariff schedule) X (US Dollar- Taka Exchange rate adjustment factor) X0.99

Part 2 Taka Component.

OMT=(OMT at tariff schedule) X 0.01

Fuel Tariff (FT).

FT= (FT at tariff schedule) X Fuel (gas/diesel) adjustment factor with base rate.

Tariff Rate = OMT+FT

The detail of the tariff calculation is shown in Annexure C.

In case of any dispute over guaranteed capacity (GC) or Force Majeure compensation or liquidated damage etc. the BPDB and IPPs have to select an Expert either through mutual agreement or through International Chamber of Commerce Center (ICC) to mitigate the dispute. The duration to mitigate such dispute could be 90 days. However, it may continue even longer In case of dispute over guaranteed capacity (GC) it is not mentioned whether the IPPs will continue production or not.

For routine testing and maintenance the IPPs are allowed a maximum of 36 days of outage in a year with full capacity payment. In case of more than 36 days of outage in a year due to a cause disputed by the parties, the matter will be resolved by a mutually agreed Expert.

3.4.2. Lower Tariff Rate IPPs[12]

After the Commercial Operations date, the Dependable Capacity shall be tested annually at times mutually agreed upon by IPPs and BPDB for the Facility, provided that such Dependable Capacity Test shall to the extent possible be conducted within one month after the completion of a scheduled outage.

From and after the commercial operation date, BPDB shall pay to the IPPs, for each month, Capacity Payment, in accordance with the agreement, for making available the Dependable Capacity in such month, which shall be calculated by the agreed formula in the PPA.

From and after the commercial operation date, BPDB shall pay to the IPPs, for each month, the Energy Payment, in accordance with the agreement, for Net Energy generated and supplied to BPDB, which shall be calculated by the agreed formula in the PPA The formula for total payment includes capacity payment and energy payment as described below:

Capacity Payment

$CP_{mn} = CPNE_{mn} + CPE_{mn}$

CP_{mn} = Capacity Payment payable for month "m" of contract year "n" in Taka.

$CPNE_{mn}$ = Non-Escalable Capacity Payment payable fpr Month "m" of Contract Year "n" in Taka and calculated as under.

CPE_{mn} = Escalable Capacity Payment payable for Month "m" of Contract Year "n" in Taka and calculated as under.

(i) Calculation of CPNE.

$CPNE_{mn} = RNECP_n \times CE_m \times DC_m$.

$RNECP_n$ = Reference Non-Escalable Capacity Price

CE_m = The rate at which Bangladesh Bank sells one dollar in exchange for Taka, as determined by the Bangladesh Bank in the published Exchange Rate Bulletin or publication of the Bangladesh Bank, on the first day of the month

DC_m = Actual rated Dependable Capacity in the month "m".

Energy Payment

EP_{mn} = $VOMP_{mn}$ + FP_{mn}.

Where:

EP_{mn} = Energy Payment payable in Taka for month "m" of Contract year "n".

$VOMP_{mn}$ = Variable Operation and Maintenance Payment payable in Taka for month of contract year "n' and calculated as under.

FP_{mn} = Gas Payment payable in Taka in month "m' of contract year "n" and calculated as under.

(i) Calculation of VOMP.

$VOMP_{mn}$ = Variable Operation and Maintenance Payment payable in Taka for month "m" of contract year "n" and calculated as follows;

$VOMP_{mn}$ = $VOMP(US)_{mn}$ + $VOMP(TK)_{mn}$,

where:

$VOMP(US)_{mn}$ = Foreign Variable Operation and Maintenance Payment denominated in dollars and payable in Taka for month "m" of contract year "n".

$VOMP(TK)_{mn}$ = Local Variable Operation and Maintenance Payment denominated in Taka and payable in Taka for month "m" of contract year "n".

Total Payment = Capacity Payment + Energy Payment.

If, the result of a Dependable Capacity Test carried out as per the agreement is below the Dependable Capacity, the rectification period shall be an eighteen (18) month period commencing from the day following the date on which such annual test was carried out, provided however that if the IPPs has taken reasonable steps to restore the Dependable Capacity equal to or grater than the Threshold Capacity any time prior to the expiry of such eighteen (18) month period, the rectification period shall be extended for an additional six(6) month period.

BPDB has to pay to IPPs due to the political unrest termed as Political Force Majeure Event at commercially reasonable rates upon notice to BPDB.

The IPPs shall be exempted from any imposition of tax on the sale of electricity to BPDB

Where the IPPs maintains its existence as a company incorporated under the laws of Bangladesh operating exclusively as a power generation company, the IPPs shall, commencing on the commercial operations date and continuing until fifteenth (15^{th}) anniversary of the commercial operation date, be exempt from taxation or withholding tax in Bangladesh on its income

3.5. Experience of IPPs in Other Countries

There are many countries in the world where there are IPPs to generate electricity. Most of the states in America allow IPPs to create a competitive market. Many states opted for absolutely free market of electricity while many others were more conservative. The experience of California where blackout became common in recent years is mainly attributed to free marketing of electricity.

In the UK, the power sector was with the government for long time On 1st April 1990 [24], the electricity supply industry for England and Wales was fundamentally reformed. Prior to that, a national owned company, the Central Electricity Generation Board (CEGB), which had a virtual monopoly of generation and owned and operated the national high-voltage transmission system, had dominated the industry Twelve regionally based companies, also owned by central government and then known as Area Boards, operated the local low-voltage distribution system and supplied electricity to final consumers, reading meters and sending out bills.

While the reforms that took place are generally referred to in Britain as privatization, they actually comprised a number of distinct and separate changes. The basic philosophy was to separate, or deintegrate the industry into four main component parts-generation, supply, transmission, and distribution. The activity of generation and high-voltage transmission are easily understood, but the idea that distribution and supply could be separate activity is less familiar. Distribution covers the operation of the low-voltage distribution system while supply is the commercial activity of purchasing power and selling it to consumers. It was believed that generation and supply could be made competitive, while transmission and distribution were natural monopolies. In the new structure, competitive procedures were introduced for generation and supply and the barriers to entry for new companies minimized. For transmission and distribution, a new system of regulation was introduced, designed to provide strong incentives for the companies operating the monopolies to improve their efficiency, passing on many of the benefits to consumers.

In short therefore, the reforms comprised four main elements: privatization; restructuring and de-integration; the introduction of competition in generation and supply; and the creation of a new body for economic regulation.

In India, the power generation, transmission and distribution were mainly done by state government agencies Some major power stations are owned by the central government organizations. In recent years Maharastra State Electricity Board allowed an American Company to establish a power plant at Dabhol. The contract price per kwh appeared to be very high and eventually the power purchase agreement was not honoured and the case ended up in the court

Every country that has mentioned in privatization of electricity generation, transmission, and distribution system has strong regulatory authority. Without such strong authority privatization and perfect competition leads to chaos and inefficiency as happened in the state of California in the USA.

3.6. Impacts of IPPs

3.6.1. Relief of Power Shortage.

Independent Power Producers started generating power for the country when there was acute shortage of power. Because of the funding constraint from the donor agencies the government was also not in a position to establish power plants with cash money However, allowing IPPs to generate power and buying electricity from them was not all blessings. We have seen the burden on BPDB due to payment of electricity. Strategically BPDB is becoming dependent for power from the IPPs Also, the price paid by BPDB for the electricity is not the lowest. On the other hand, considering the importance of the electricity in economic development it is difficult to say explicitly whether IPPs are good or bad for the country. Without resolving the debate it is possible to say that electricity from IPPs were helpful to meet the acute shortage of power The country at least meets the major part of the demand (17.10%) from the agriculture and the industry sector. Apart from that the IPPs have brought in state-of-the-art technologies and had some role in transferring the technologies. The next section describes this contribution.

3.6.2. Technology Transfer from IPPs

Private power generating companies purchased plant & machinery from France, Germany, & some other technically developed countries. These are technologically new, efficient and sound, and are in good operational condition The efficiency is more than that of comparable BPDB plants. Most of the plants have capability to deliver maximum power at 30-60 degree Celsius ambient temperature. These plants are state-of-the-art technologies for power generation. Some of them come with distributed control system, very advance combustion control and emission system. One of the power plant has remote operational logging even outside the country. These plants were installed and commissioned by foreign technicians and consultants in association with trained local engineers and technicians. All the companies recruited local engineers and technicians to take over operation of the plants. They were provided training on specific areas. The training programmes were carried out in different stages.

Pre Commissioning Training.

Before installation of the plant, most of the companies recruit few experienced engineers and technicians They were trained by the Original Equipment Manufacturing (OEM)companies on specific technologies like Generator, Gas turbine, Sub-Station & Switchgears, Transformer. These trainings were imparted at the OEM plant site where assembling/manufacturing of the plant items were done.

Commissioning Training.

The engineers, consultant and technicians from foreign countries along with trained local engineers or technicians installed and commissioned the plants. During this operations the local people received another on-site, hands-on training. This mode of training is very effective because foreign and local people work in a team and there is always scope for learning. It may be mentioned that installing and commissioning a plant is a very unique opportunity to learn about the plant from scratch This experience is invaluable and useful for subsequent operation and maintenance of the plant.

Operation and Maintenance training.

The company who supplied/assembled the plant machinery usually provide routine operational and maintenance training which was the part of the agreement with the company. Other than these, companies by their own arrangement provide operational and maintenance training to its staff to run the plant smoothly. In some cases the supplying company operate the plant for certain period and gradually hand-over the responsibility to plant O&M staff within an agreed time period. Some of the plant has separate O&M Company. But most of the supplying companies provide maintenance and servicing during agreed warranty period

On Job Training.

To meet the future demands and get new professional engineer and technician these private companies recruit engineers and technicians with relatively less experience or without experience. The companies provide training to them while working with expert people This mode of training is also effective. Discussion with plant management revealed that, they got very good engineers through such training programme.

Technical Help from Supplying Company.

The supplying companies, of course, help the IPPs to run the machinery within warranty period and also after warranty period due to business strategy. This is often done when local agents fail to solve the problem. During this kind of technical assistance local engineers learn the techniques.

Observation on Technology transfer from IPPs.

Technology transfer is multistage process In case of power plant technology there could be five stages as shown in figure 4.2

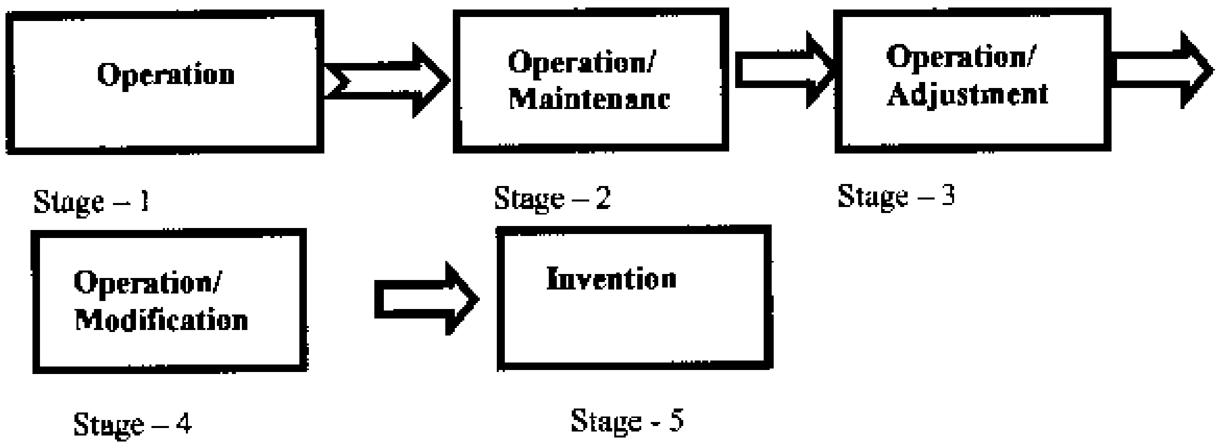


Figure.4.2: Stages of Technology Development.

Transition from one stage to another is in fact the transition of the knowledge and skill of the people involved in the process. In this aspect, the training programmes and the ways these were carried out proved to be very effective. The IPPs are operating for only four years. It is still early to see whether these trainings can deliver at stage three and upwards. However, discussion with trained people conveyed the massage that they are confident to carry out stage three activities.

3.6.3. Potential Adverse Impact of IPPs

Availability of electric power is a very important issue for the national development. Presently IPPs can be established with 100% foreign ownership. Without very strict regulatory body and anti-monopoly law, the country may become highly dependent ou the IPPs for power vital to the nation. IPPs may try to choose their technology irrespective of the demand pattern in the country. They are also likely to exploit different benefit scheme without much contribution to local value addition.

CHAPTER-04

Electric Power Management with IPPs in the System of Bangladesh.

CHAPTER-04

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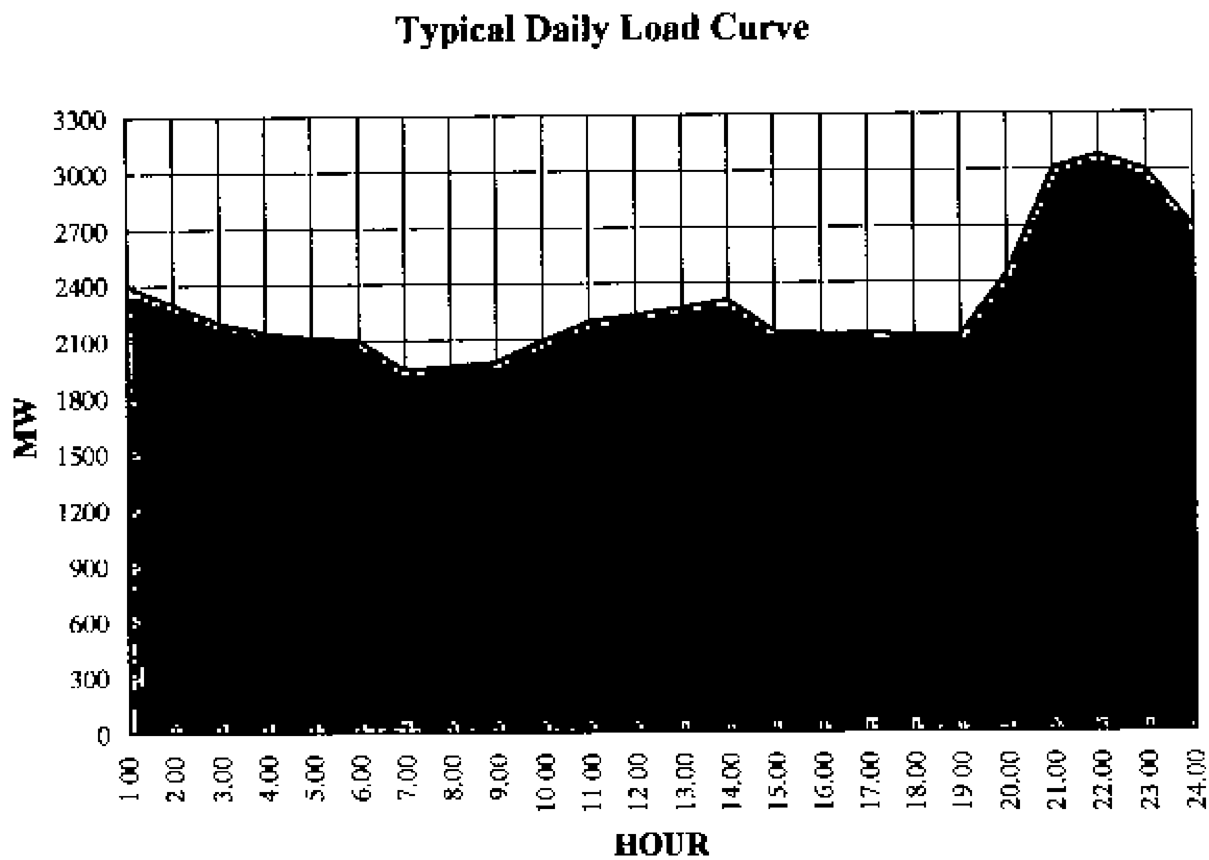
4.1. Introduction

Bangladesh needs to achieve and sustain an annual electric growth rate of 8-10% to meet the demand of electricity in the period of 2001-2007. But due to non- availability of fund Bangladesh had to go for privatization in 1998. Before that BPDB was the only organization in generation and transmission of Electric Power in the Country. In the distribution sector DESA and PBSs were in operation along with BPDB. Until 1998, the management of generation and transmission of electric power was monopolistic With the introdnction of IPPs and PGCB the electric power system management has become a multi-party business with lot of communication, co-ordination and alliance maintenance. As an umbrella organization BPDB has to manage different entities on technical as well as strategic fronts. As a result, management of the system has become non-linear and complicated.

4.2. Growth of Demand and Generation and the Role of IPPs

The power system master plan projected in 1995 that the demand in FY 2007 will be 6071MW [3] and demand in FY2015 will 11,439MW. These growth plans warrant 10 per cent increase in 2007-2015 period. Planned generation capacity in FY2007 by BPDB will be 5693MW and by IPPs 2050MW resulting in total capacity of 7743MW. This will provide 28% reserve margin in 2007. To meet the demand in 2007 as estimated in the PSMP-1995 (6071MW) new generation capacity must be added during 2001-2007 period. It is planned that during this period BPDB will add 3000MW [3] and new and old IPPs combine will have 26.5% of the total generation capacity of the system. This share of IPPs is less than the reserve margin of the system. Strategically, keeping the combine IPPs capacity within reserve margin is important Otherwise their combine capacity might dictate the management of the system. It is also expected that IPPs will come with most efficient technology i.e. combine cycle plant. BPDB is also likely to procure similar type of technology. In such situation there will be competition for the base load The load pattern in Bangladesh is not uniform through the day and night. The load pattern varies between the day and night. The maximum demand occurs during the evening hours termed as 'peak hours'. The extent of this variation is measured in terms of load factor, which is the ratio of average and maximum demands. For economic reasons, it is desirable to have a high load factor, as this would permit better utilization of plant capacity. The cost of energy supply during peak hours is high as some relatively less efficient machines are also added for a short duration during peak hours.



(Source: System Planning of BPDB)

Figure-4.1: A Typical Daily Load Curve in Summer Season

It is seen from the present load curve in figure 4.1, that the average base load is 2150MW, which is 70% of the maximum demand. If we assume that the characteristics of the daily load curve will be similar in FY2007 then the base load demand will be 4249.7MW. If IPPs will have combine cycle plants they will prefer continuous load. In such situation IPPs share of the base load will be 56% leaving 1592MW for BPDB, which will be only 25% of its generation capacity of 5693MW. This will not be a desired situation. The load sharing between the IPPs and BPDB is thus a question of choice of technology also. It is probably wise to workout a long-term load sharing strategy based on which BPDB and IPPs will procure generation technology. This long-term load sharing strategy must also consider the cost-minimization aspect of generation of electricity.

4.3. Financial Management.

Financial position of BPDB was going from bad to worse. The situation further worsened after the introduction of IPPs in the system Table 4.1 shows the net loss of BPDB for four years of which first two years there were no financial transaction with IPPs.

Table 4.1: Actual Loss in Four Financial Years.

YEAR	LOSS (Crore Taka)
1996-97	125.86
1997-98	82 48
1998-99	320.40
1999-00	394 41

From financial reports it has been observed in Section 2.4 that causes of main loss are fluctuation of exchange rate and interest on loan, which termed as unavoidable non-technical loss. In terms of cost and revenue also BPDB is at disadvantage. BPDB at present sells electricity to its bulk customer, REB at Tk.1.84/Kwh and DESA at Tk.1.91/Kwh. The average generation cost of BPDB (Including IPP) is Tk. 1.71/Kwh. The transmission and distribution cost is Tk.0.914/Kwh. So, the total cost is about Tk 2.624/Kwh. It is clearly evident that BPDB loses at least Tk.0.71/Kwh for 75% of its output consumed by DESA and REB. On top of that, collection to generation ratio is 69 to 70% meaning BPDB is borrowing money to feed DESA and other bulk customers. Due to this BPDB could not pay to gas and oil company for its oil and gas. At present BPDB cannot pay to IPPs for its electricity. The interest on loan and payment increasing more and more. This results in the liquidity Problem of BPDB Financial problem of BPDB may be addressed in number of ways. These are:

- i. Reducing generation cost by optimum mix with IPP and BPDB.
- ii. Revising tariff structure on profit basis
- iii. Reducing system loss from present level to standard level.
- iv Improving cash flow

Discussion on all these issues except the first one is beyond the scope of the present study.

4.4. Generation Mix Between BPDB and IPPs

As per the agreement GOB has many buying options from IPPs. Thus BPDB can assess different generation mix for cost minimization. In this study few probable options within the bound of power purchase agreements are analyzed. Bounds of the PPAs are basically constraints of the optimization problem Following are the contractual constraints from the PPAs:

i. GOB has to pay for a minimum amount of power whether it takes the power or not.

ii. GOB has to buy the power from each IPP at different rate at different plant factor.

iii. The payment has to be made in US dollar at current exchange rate.

iv BPDB has to pay IPPs on the basis of an agreed price formula.

The subsequent financial analyses are the expected demand in FY 2007 as projected by PSMP-1995. Different situation termed as options are considered. The adjustment factor for exchange rate is taken to be 1 7 based on the trend of last 20 years Similarly adjustment factor for gas price is taken to be 2.33 based on the trend of past changes. In these financial analyses two kinds of IPPs are considered, one with higher tariff rate and the other with other with lower tariff rate. The maximum plant factor in FY2007 is taken to be 80%. Table 4 2 shows the unit price for different generation mix options The detail calculation of unit price of power for different options is shown in Annexure "D". Different options considered are as below:

Option-1: Maximum power from IPPs and rest from BPDB.

In this case IPPs are allowed to produce its maximum capacity (80%PF) and remaining part should be fulfilled by BPDB.

Option-2: Contracted minimum from IPPs and the rest from BPDB

IPPs are allowed to produce the minimum contracted capacity (50%PFfor higher rate IPPs and capacity payment for low rate IPPs) and the remaining part from BPDB. (It may be mentioned here that IPPs must be paid at least 50% of their plant factor capacity even if BPDB buys less than 50%)

Option-3: Sharing on the basis of the past experience.

Experience of generation sharing for last 4 years shows that IPPs are allowed to generate power at 60-65% PF. In this option it is assumed that similar sharing will continue in FY2007 and as such 65% PF for IPPs is considered.

Option-4: Special strategic consideration.

Under this Option, if IPPs of higher tariff rate are allowed only capacity payment as per the contracted bond and IPPs of lower tariff rate will be allowed to operate at its maximum generation capacity then BPDB will have better advantage on strategic management.

In these analyses the total load is divided into base load and peak load. Both base load and peak load are shared according to the options. The analysis is done for total projected demand of 6071MW in 2007 by PSMP-1995. This demand is considered as the maximum in the year The calculation is done for a 31-day month. The IPPs under the PBSs are not considered in the analysis. Generation cost of BPDB is the trend extrapolation of past cost data, which is TK 2 40/Kwh.

From the analyses it is evident from Table 4 2 that the overall tariff rate in Option-1 is lowest (TK. 2.24) but the total power generation capability in the base and peak load for the IPPs are 80% of its generation capacity while the utilization of the plants of BPDB will vary both in the base load and in the peak load hour. Table 4.2 shows the base and peak demand met by BPDB plants are 2640MW and 4437MW respectively which is 46% and 77% of its installed capacity (5693MW) It is evident from this options that IPPs are loaded to 80% pf their installed capacity at all times while slightly less than 50% of BPDB generation capacity will be idle during the base load period

Option 3 provides the next low cost arrangement, which is Tk.2.39/kwh In this option IPPs are run at 65% PF at most At least 51% of BPDB capacity will be utilized during the base -load period and 83% during peak load period.

Option-4 results in highest tariff, which is Tk. 0.28/kwh higher than the lowest option But this option provides a strategic advantage. In this option BPDB will be able to maneuver with the IPPs within the bounds of the contracts.

Table 4.2: Unit generation cost for various generations mix options.

Options	Load Sharing (Base load -70%, 4192MW in 2007	Unit Cost from IPPs with Higher Tariff rate		Load Sharing (Peak load- 5989MW in 2007	Unit Cost from IPPs with Lower Tariff Rate	Weighted Average Unit Cost For the Whole System (Tk/Kwh)
		Liquid Fuel	Gas			
Option.1 580MW for high rate IPPs &972MW for low rate IPPs.	IPP-1552 BPDB-2640	IPP-4.80 BPDB-2.40	IPP-3.68 BPDB-2.40	IPP-1552 BPDB-4437	IPP-0.84 BPDB-2 40	2 24
Option.2 362.5MW for high rate IPPs & 607.5MW for low rate IPPs.	IPP-970 BPDB-3222	IPP-4.94 BPDB-2.40	IPP-4.53 BPDB-2.40	IPP-970 BPDB-5019	IPP-1.39 BPDB-2.40	2.42
Option.3 747MW for high rate IPPs & 790MW for low rate IPPs.	IPP-1261 BPDB-2931	IPP-4 87 BPDB-2.40	IPP-3.82 BPDB-2.40	IPP-1261 BPDB-4728	IPP-1.59 BPDB-2.40	2.39
Option.4 NilMW for high rate IPPs & 1215MW for low rate IPPs	IPP-1215 BPDB-2977.	IPP- BPDB-2.40	IPP-2.62 BPDB-2.40	IPP-1215 BPDB-4774	IPP-1.76 BPDB-2.40	2.52

4.5. Strategic Management of Power with IPPs.

At present BPDB and IPPs power production ratio as on June 2001 is 82.90% & 17.10% respectively. The reserve margin at that time was 13%, which is not sufficient to meet the power demand and maintenance of the plants with schedule outage. According to the PSMP, planned future power generation capacity in the year 2007 will be 5693MW(73.52%) by BPDB and 2050MW(26.48%) by the IPPs The projected demand at that time will be 6071MW, which ensures a reserve margin of 28%. Experience from power generation industry suggests that around 30% reserve margin is good enough for a system to carry out regular maintenance of the plants. However, this reserve margin is obtained by taking IPPs capacity in consideration. Strategically BPDB becomes dependant on the IPPs for its regular maintenance The reserve margin and the share of IPPs in the power system are two strategic figures for an autonomous system like ours. Since the generation capacity for the reserve margin will be at BPDB's hand, it will be in a comfortable position to stand any pressure from the IPPs as long as their combined capacity is less than the reserve margin.

REB covers the distribution in rural areas and some industrial areas like Narayangonj, Savar etc. They have 25 per cent business on distribution sector of the power system. Recently REB is installing 10MW capacity power stations with an aim to become independent PBSs. But the basis of this independency is not known and strategy is also not known. If the PBSs become independent in the long-run, then BPDB will have to reiterate its development plan It may be mentioned here that at present, PBSs combined distribute about 25% of the total generation of the country.

CHAPTER-05

Summary and Conclusion

CHAPTER-05

Summary and Conclusion

5.1 Summary

In this study the generation of electric power and its management has been discussed Bangladesh Power Development Board used to be the only organization with mandate to generate power for sale until 1996 Due to continuous shortage of power and government's inability to set up new generating station, it was decided by the government in 1996 that private companies will be allowed to generate power and sells it to BPDB BPDB will transmit the power and sell it to existing regional and rural power distribution authorities In 1998 the first private sector power plant came into operation. Since then five more private power plants were added in the generation fleet. Organizational reform also took place within BPDB during this period The study aimed at looking into the effect of all these changes specially the effect of private power producers (IPPs) on the management of electric power in the country

Historically, BPDB used to generate, transmit and distribute electric power in the country. Still BPDB is involved with all these stages of the business. With the introduction of IPPs, DESA, DESCO, PBSs of REB and PGCB the role of BPDB has diminished but its importance has remained the same because of its key position as a defacto regulator. Therefore, to study the power management system in Bangladesh one cannot avoid the study of the operation and management of BPDB

5.1.1. Operation and Management of BPDB

The main points observed in the Operation and Maintenance of BPDB are listed below.

i. Due to availability of indigenous fuel (Natural gas) 87.23% of generation capacity located in the east of river Jamuna.

ii. 10.33% of generation capacity of BPDB already crossed their economic life and another 15% will be past their economic life by 2007.

iii. Overall efficiency of BPDB plants is 31.63%. However, many plants have efficiency between 12%-18%.

iv. The yearly growth rate of generating capacity of BPDB during 1989/90- 1997/98 was about 4%. After this period there were no addition of generating capacity under BPDB management.

v. To improve their cost of operation BPDB introduced new system in generation and distribution system It created separate business unit both in generation and distribution termed as Strategic Business Units (SBU).

vi. In generation, existing Haripur 360MW power station was converted to a SBU with almost 80% of total financial and administrative powers to PMB (Plant Management Board) in respect to material, equipment, machinery, service and human resources This provided a good degree of autonomy to the management of the plant. The result was for the better Targeted goals has been achieved by SBU-HPS within one year.

vii. In distribution, existing Jamalpur and Sherpur distribution division was converted to two separate SBU with a view to improve financial condition as well quality of service and reduce system loss. These SBUs were given certain degree of autonomy in respect of target setting incentive/penalty scheme etc After the first phase the result from SBU was quite encouraging.

viii BPDB has handed over part of the transmission network to a newly created company called PGCB in July 1997. PGCB charges Tk.0.17/Kwh wheeling charge

ix. PGCB is going to take over the whole transmission network by December 2002. PGCB will be the sole authority for the development and operation of transmission system.

x. BPDB is still responsible for 25% of total power distribution. In the long term REB is supposed to take over the task of distribution in rural areas. In medium term BPDB will continue to distribute power in the district towns.

xi. As a distribution organization PBSs are doing better than DESA or BPDB The formation of SBUs in the BPDB distribution system is similar to operation and maintenance of PBSs but PBSs are more autonomous.

xii. Average BPDB consumer growth per year is 5.95%.

xiii. The combined net system loss of DESA and BPDB as technical, non-technical and others in 1999-2000 was 36% and overall collection has been around 80% of billing. The overall collection to generation ratio has been only around 69% The individual system loss of BPDB was 27%, DESA 29 65%, DESCO 32% and REB 16.24%

5.1.2. IPPs (Independent Power Producers) and their Operation in Power Sector.

The key features of the IPPs and their operation in power sector has been described below:

i. According to PSMP-1995, it is projected that the investment required to meet the power demand in 2010 will be a about US$ of 6.6 billion which will be huge amount for the Government of Bangladesh investment portfoliu.

ii. Realizing the short fall of fund, government allowed private sector power generation. First private sector power came into operation in 12 September 1998.

iii. Starting from 1998, so far 685MW has been added from the private sector and 960MW more is in construction stage. Most of the generation plants are located in the East zone due to availability of cheap natural gas.

iv. Most of the IPP plants are state-of the-art technology i.e. combine cycle technology.

v. The efficiency of this type of technology is about 45%.

vi IPP plants have modern automation and control system including distributed control system.

vii. One of the plants has combustion technology DLN (dry low nox) which is environment friendly.

viii. REB started installing small power station of 10MW capacity in their PBSs, with an aim to become independent PBSs.

ix. IPPs are operating in power sector under Power Purchase Agreement (PPA). Initially the IPPs were contracted at higher tariff charge to BPDB (Tk.3.68/Kwh) but later on contracts were signed with IPPs at a much lower tariff (Tk.0 84/Kwh)

x The contracts are mostly in favor of IPPs for its operation and finance.

xi. BPDB has a binding to supply gas to the private power plants

xii. Payment to the IPPs is calculated as per the formula agreed in PPAs and payment will be made in foreign currency (Dollar).

xiii. BPDB has to buy at least 50% PF equivalent of power from the higher tariff rate IPPs. However, if BPDB buys less than that it has to pay OMT for 50% PF and fuel charges. For the lower tariff rate IPPs the payment formula is similar for such buying situation.

xiv. If any dispute arise regarding capacity, Force Majurie event, and liquidated damage event between IPPs and BPDB then it require minimum 22 month time for higher rate IPPs and 90 days for lower rate IPPs to settle the dispute during this period payment will be decided by consultant or third party

xv. IPPs are exempted from VAT, TAX, Custom Duties and income tax on sale of electricity.

5.1.3. Electric Power Management with IPPs in the System of Bangladesh.

The key features of the electric power management with IPPs in the system of Bangladesh in power sector has been described below:

i. According to PSMP-1995, the demand in 2007 will be 6071MW and demand in 2015 will be 11,439MW The capacity planned to install by 2007 is 7743MW, of which BPDB will have 4593MW capacity and IPPs will have 2050MW(including 110MW from IPPs of PBSs).

ii IPP generate power and sell it to BPDB They are not involved in transmission and distribution management of the system. Transmission, load dispatch and distribution are still regulated by BPDB.

iii. Some of the IPPs specially those contracted in the first-round have tariff rate even higher than BPDB production cost.

iv According to present development plan the reserve margin will be 28% in 2007 The share of IPPs generation at that time will be 26.5%

v. Some IPPs came with most efficient technology i.e combine cycle technology which is more suitable for base-load operation.

vi. In the load pattern of Bangladesh the base load is 70% of the peak load and the peak load lasts for only 6 hour.

vii. At present IPPs are allowed about 30% of the base load which is about 60-65% of their combined capacity.

viii The production cost per unit generation in peak hour is more because relatively less efficient machines come into production during peak hour.

ix. BPDB sells electricity to its bulk consumer like DESA at price lower than its generation cost. As a result BPDB is losing huge amount of money every year.

x. The loss of BPDB further compounded because of the exchange rate fluctuation cover in the payment of IPPs and other loan obligations.

xi. Unit cost for different generation mix options was calculated and it was found that Option-1 which allows 80% PF operation of the IPP plants provides the lowest unit cost (Tk 2.24/Kwh).

xii However, Option-1 is strategically not very attractive as this would allow about 37% of the total load which is more than the reserve margin of 28% In that consideration Option-4 is better but costly (Tk.2 52/Kwh).

xiii. IPP plants have state-of-the-art technologies. Most of their employees are from Bangladesh

xiv. They have well planned and effective training program for their human resources which is an important factor of technology transfer

xv. IPPs have developed good local capacity. They have achieved operation and routine maintenance capacity. In some cases they have developed capability to adjust technologies to local requirement.

5.2. Conclusion

Independent power producers started delivering power to the power market at a time when BPDB or for that matter the government was unable to setup new plants to add electric power in the national grid. Introduction of IPPs has affected the power system management in different ways These are as below:

i. IPPs provided power to the grid when there was a huge demand -supply gap and thus provided some relief to the power system management.

ii IPPs brought in state-of-the-art technologies in the country and developed local capacity for operation and maintenance.

iii Some of the IPPs showed that electric power could be produced at a much lower cost. These examples probably led BPDB to think over its production cost and formation of SBU power plants and distribution units This new method of managing by delegation of power and responsibility is likely to improve the operational efficiency of BPDB.

iv. In generation IPPs are increasingly having a greater role. BPDB still generates a major part of the power production With power demand growing, the role of

BPDB as a major player should continue for strategic reasons. Present share of IPPs is strategically comfortable.

v. Privatization of power generation, transmission and distribution in other countries of the world has mixed results. Evidence of cartel and consequent adverse impact on power management even in developed countries should be considered seriously for developing countries like Bangladesh

vi In almost all countries power system is strongly regulated to avoid cartel or monopoly Bangladesh lacks appropriate anti-monopoly laws and regulations. Therefore, any private participation in power system of the country must be regulated very strongly

5.3. Recommendation

The following recommendation can be made from the study:

i Contracts of Higher tariff rate IPPs may be reviewed in terms of tariff, contract duration, technology etc.

ii. The private-public role of power generation should not exceed 1.3 ratio.

iii. Production cost minimization by optimum allocation to different generating stations should be followed. In this regard, an optimum allocation strategy can be followed with the aid of suitable computer program

iv Strategic Business Unit methodology of BPDB should be continued and expanded to delegate authority and responsibility. This should lead to better operational efficiency of BPDB.

v The study did not assess the effect of setting up power plants by BPDB by borrowing money from international source at commercial rate. A study may be taken to determine the financial implication for such strategy vis-a-vis the strategy of allowing IPPs in the system

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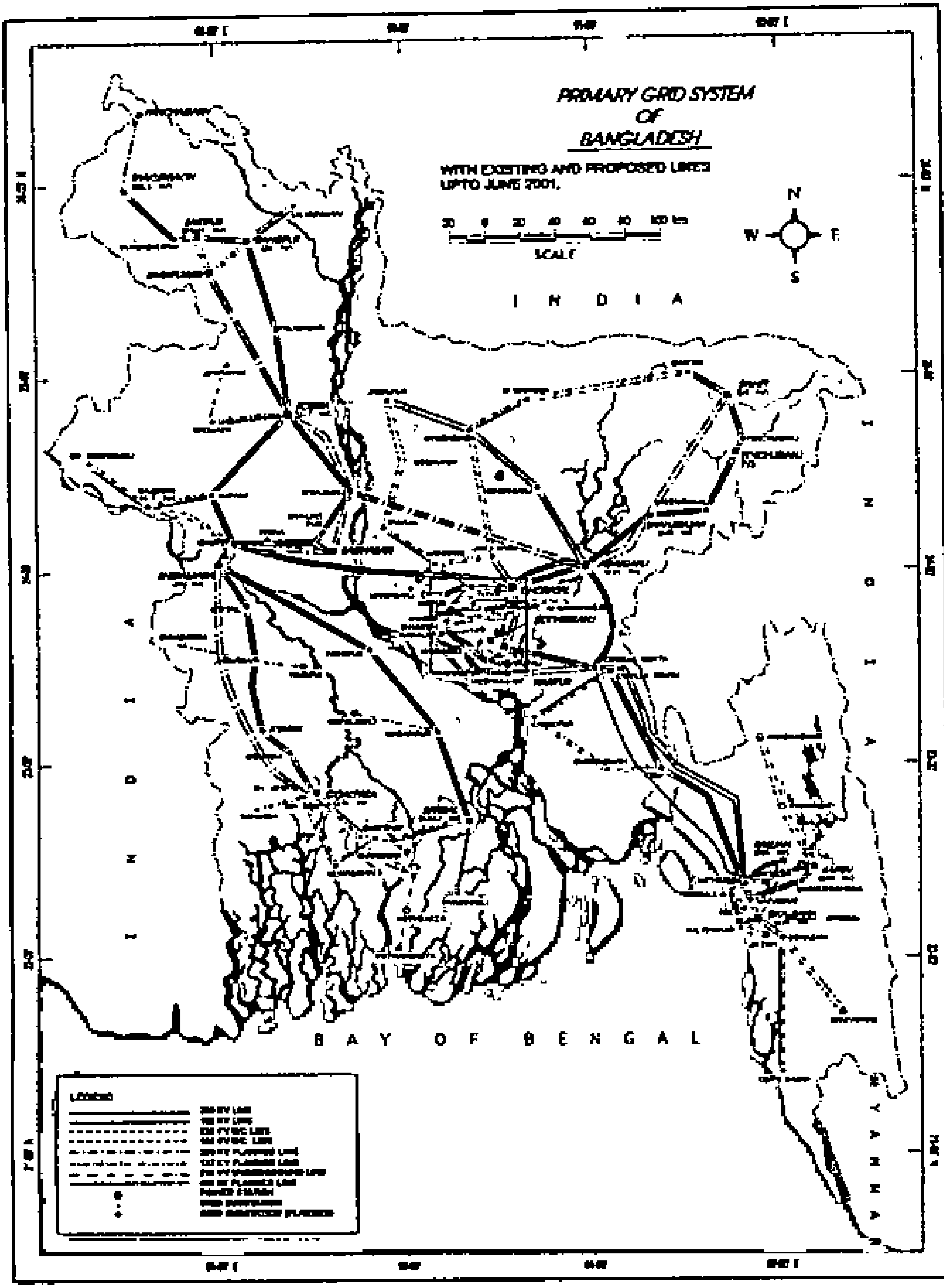
PRIMARY GRID SYSTEM
OF
BANGLADESH
WITH EXISTING AND PROPOSED LINES
UPTO JUNE 2001.
SCALE
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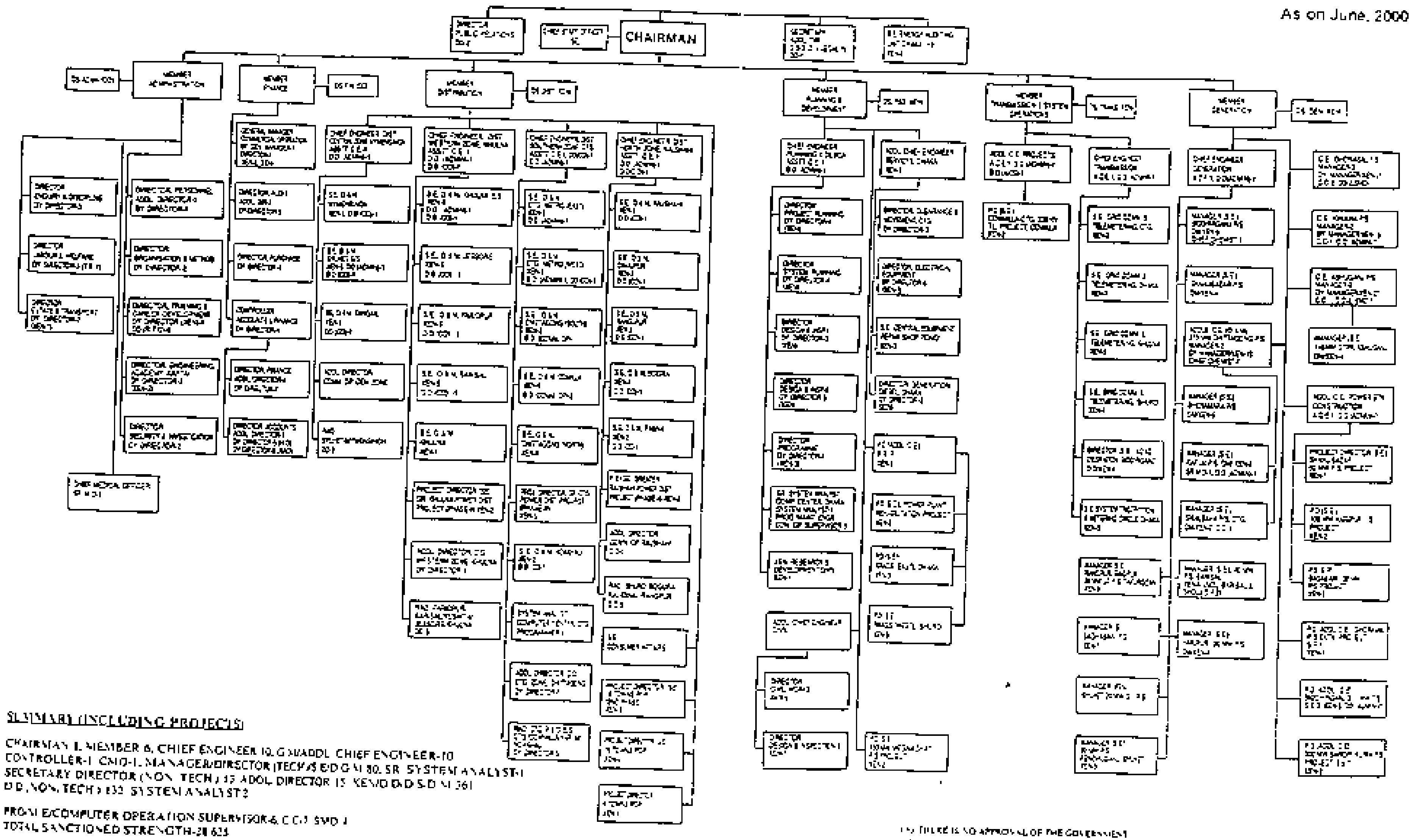
BAY OF BENGAL

ORGANISATION CHART OF BANGLADESH POWER DEVELOPMENT BOARD

(SHOWING POSITION DOWN TO XEN AND EQUIVALENT)

As on June, 2000



SUMMARY (INCLUDING PROJECTS)

CHAIRMAN 1, MEMBER 6, CHIEF ENGINEER 10, G.M/ADDL. CHIEF ENGINEER-10
CONTROLLER-1, CMO-1, MANAGER/DIRECTOR (TECH) 45 D.G.M 80, SR. SYSTEM ANALYST-1
SECRETARY DIRECTOR (NON TECH) 15 ADDL DIRECTOR 15 XEN/D.D/S.D.M 361
D.D. NON TECH) 132 SYSTEM ANALYST 2

PROM E/COMPUTER OPERATION SUPERVISOR & C.C.O SMD 1
TOTAL SANCTIONED STRENGTH-21 625

(*) THERE IS NO APPROVAL OF THE GOVERNMENT
AFTER 10-06-91 FOR THE OFFICES UNDER ENERGY AUDIT UNIT

Sample Tariff Calculation

Invoice for the Month of May-2001

The Bangladesh Power Development Board

WAPDA Building
Motijheel C/A
Dhaka 1000
Bangladesh

Invoice No : 33 (KPCL/FCOD/2001/May)
Invoice Date . 04- June 2001

Monthly Plant Factor

NEO (Net Electrical Output) for the Month. kWh.	38,793,200
Guaranteed Capacity (GC). MW	110
Number of Hours in the Month	744
Monthly Plant Factor	47.40127%

A. OMT Payment

OMT Adjustment (from Sch 5 Part E). TK = OMT adjusted x Ex rate current/Fx rate base x0 99
= 1.631912000 * (57.5/42 612) * 0 99 = 2.180057040 TK

OMT Taka (from Sch 5. Part F) Tk = OMT adjusted * 0 01 = 0 016319120 TK

Total OMT payment Taka =(OMT adjusted + OMT Taka) * NEO = 85.204.459 66 TK

Minimum Tariff Payment (MEP)

MGE = GC (kW) * Hours in month * 0 5 = 40,920,000 00
ph = Hours lost as per Sch 4 Part B of PPA = 369.20
MEP (MEP = O if MPF> 50% Tk= (OMT Adj + OMT tk)* min(MGE-NEO.Ph*GC) = 4,671,252.82 TK

OMT CHARGE, Taka = OMT Payment+ Minimum Tariff Payment= 89,875,712 48 TK

B. FT CHARGE

FT (From Schedule 5 of PPA), Taka = 0 935291 TK

FT Adjusted (for current fuel price)= FT * FPn/ FPh = 0.935292 * 10.49008833 / 4.51000000 = 2.175451264
(Pl. see attachmeng 2) 4.51000000

FT Charge, Taka = FT Adjusted * NEO= 2.179128 =84.392,715 98 TK

Appendix –1 to
Annexure –C

Extract from Sehedul –5 of PPA
Khulna Power Company Ltd

1. part A; Tariff on Liquid Fuel

Period of Power Purchase		Rate of tariff in US $/kwh for monthly plant factor				Rate of tariff in Tk./kWh for monthly plant factor			
		50%	60%	70%	80%	50%	60%	70%	80%
1st Year (Base Year)	FT	.021949	0 21949	.021949	.021949	.935291	935291	.935291	.935291
	OMT	.38297	.037471	.036868	.36330	1.631912	1.596714	1.571019	1.548094
2nd Year	OMT	038297	.037471	.036868	.036330	1.631912	1 596714	1 571019	1.548094
3rd Year	OMT	.038297	.037471	.036868	036330	1 631912	1 596714	1 571019	1 548094
4th Year	OMT	.038297	.037471	.036868	.036330	1.631912	1 596714	1.571019	1 548094
5th Year	OMT	.038297	.037471	.036868	.036330	1.631912	1.596714	1 571019	1.548094
6th Year	OMT	.038297	.037471	.036868	.036330	1.631912	1.596714	1 571019	1.548094
7th Year	OMT	.038297	.037471	.036868	.036330	1.631912	1 596714	1.571019	1.548094
8th Year	OMT	.038297	.037471	036868	036330	1.631912	1.596714	1.571019	1.548094
9th Year	OMT	.038297	.037471	.036868	036330	1 631912	1 596714	1.571019	1 548094
10th Year	OMT	.038297	037471	.036868	.036330	1 631912	1.596714	1.571019	1.548094
11th Year	OMT	.038297	.037471	036868	.036330	1 631912	1.596714	1.571019	1.548094
12th Year	OMT	.038297	.037471	.036868	.036330	1 631912	1.596714	1 571019	1.548094
13th Year	OMT	038297	.037471	.036868	036330	1 631912	1 596714	1.571019	1.548094
14th Year	OMT	.038297	.037471	.036868	.036330	1 631912	1.596714	1 571019	1.548094
15th Year	OMT	.038297	.037471	.036868	036330	1.631912	1 596714	1 571019	1 548094

FT = The price Component on account of the cost of Fuel per kWh of energy generated. This must be commensurate with the Heat Rate specified in Schedule 1.
OMT= The price component on account of all other costs including profit per kWh of energy supplied at the Delivery Point.
Both FT and OMT together will constitute the tariff per kWh of Net Electrical Output delivered to the Delivery Point.

Appendix –2 to
Annexure –C

Extract from Sehedul –5 of PPA
Khulna Power Company Ltd

1. **part A; Tariff on Natural Gas as Fuel**

Tariff Schedule on the basis of Natural Gas as Fuel

Period		Tariff in US $/kWh for Monthly Plant factor				Tariff in TK./kWh for Monthly Plant factor			
		50%	60%	70%	80%	50%	60%	70%	80%
1st Year (Base Year)	FT	0.01060	0.01060	0.01060	0.01060	0.45169	0.45169	0.45169	0.45169
	OMT	0.03820	0.03740	0.03540	0.03630	1.62778	1.59369	1.50846	1.54682
2nd Year	FT	0.00800	0.00800	0.00800	0.00800	0.34090	0.34090	0.34090	0.34090
2nd Year	OMT	0.03200	0.02630	0.02150	0.01720	1.36358	1.12070	0.91616	0.73293
3rd to 15 th Year	FT	0.01060	0.01060	0.01060	0.01060	045169	0.45169	0.45169	0.45169
3rd Year	OMT	0.04900	0.04240	0.03220	0.03320	2.08799	1.80675	1.37211	1.41472
4th Year	OMT	0.05100	0.04420	0.03686	0.03420	2.17321	1.88345	1.57068	1.45733
5th Year	OMT	0.05300	0.04600	0.03686	0.03550	2.25844	1.96015	1.57068	1.51273
6th Year	OMT	0.05490	0.04730	0.03686	0.03620	2.33940	2.01555	1.57068	1.54255
7th Year	OMT	0.5680	0.04870	0.03686	0.03620	2.42036	2.07520	1.57068	1.54255
8th Year	OMT	0.05850	0.04990	0.03686	0.03620	2.49280	2.12634	1.57068	1.54255
9th Year	OMT	0.06030	0.05150	0.03686	0.03620	2056950	2.19452	1.57068	1.54255
10th Year	OMT	0.06210	0.05310	0.03686	0.03620	2.64621	2.26270	1.57068	1.54255
11th Year	OMT	0.06410	0.05400	0.03686	0.03620	2.73143	2.30105	1.57068	1.54255
12th Year	OMT	0.06500	0.05600	0.03686	0.03620	2.76978	2.38627	1.57068	1.54255
13th Year	OMT	0.04780	0.04080	0.03686	0.03620	2.03685	1.73857	1.57068	1.54255
14th Year	OMT	0.04920	0.04200	0.03686	0.03620	2.09651	1.78970	1.57068	1.54255
15th Year	OMT	0.05070	0.04280	0.03686	0.03620	2.16043	1.82379	1.57068	1.54255

Reference :
1. Natural Gas at Tk.475976 ($1 117)/MSCF
2. Exchange Rate US$ 1.00=Tk 42.612.Reference BPDB Memo.1626-BPDB (SEC)/Dev-110/96 dated 12/12/96.

Tariff Rate Calculation for Different Mix with IPPs and BPDB.

(For higher cost IPPs-Reference KPCL)

Option-1

Maximum power from IPPs and rest from BPDB.

A. OMT calculation

OMT = (OMT at tariff schedule) x (US dollar-Taka Exchange rate adjustment factor) x 0.99.

= 1.548 x1.7x0.99= 2.605 Tk/Kwh

OMT (taka) = (OMT at tariff schedule) x 0.01=1 548 x0.01, =0 01548 Tk/Kwh.

Total OMT (taka) = 2.604 + 0 01548 = 2.62 Taka/ Kwh.

B. FT Calculation

FT= (FT at tariff schedule) X Fuel (gas/diesel) adjustment factor with base rate

= 0.93591 x 2 33 = 2.18 Tk/Kwh

Therefore, the Tariff rate will be = OMT + FT

= 4.8 Tk/Kwh

Option –2

Contracted minimum from IPPs and the rest from BPDB.

At 50 per cent plant factor

A. OMT Calculation

OMT = (OMT at tariff schedule) x (US dollar-Taka Exchange rate adjustment factor)x 0.99

= 1.631912 x 1.7 x 0.99 = 2.746507895 Tk/Kwh

OMT (taka) = (OMT at tariff schedule)x 0.01

= 1.631912 x 0 01

= 0.01631912 Tk/Kwh

Total OMT = 2.76281912 Tk/Kwh

B. FT Calculation

FT = (FT at tariff schedule) X Fuel (gas/diesel) adjustment factor with base rate.

= 0.935291 x 2.33

= 2.18 Tk/Kwh

Tariff rate = OMT + FT = 4.94 Tk/Kwh

Option –3

Sharing on the basis of the past experience.

At 65 per cent plant factor

A. OMT Calculation

OMT =(OMT at tariff schedule) x (US dollar-Taka Exchange rate adjustment factor) x 0.99

= 1.5838665 x 1.7 x 0.99 = 2 67 Tk/Kwh

OMT (taka) = (OMT at tariff schedule)x 0 01

= 1.5838665 x 0.01

= 0.015838665 Tk/Kwh

Total OMT = 2.69 Tk/Kwh

B. FT Calculation

FT = (FT at tariff schedule) X Fuel (gas/diesel) adjustment factor with base rate.

= 0 935291 x 2 33

= 2.18 Tk/Kwh

Tariff rate = OMT + FT = 4.87 Tk/Kwh.

Option –1(Fuel will be Natural Gas)

Maximum power from IPPs and rest from BPDB.

A. OMT Calculation

OMT = (OMT at tariff schedule) x (US dollar-Taka Exchange rate adjustment factor)x 0.99

= 1 54255 x 1.7 x 0.99 = 2.6 Tk/Kwh

OMT (taka) = (OMT at tariff schedule)x 0.01

= 1.54255 x 0 01= 0.0254255 Tk/Kwh

Total OMT = 2.63 Tk/Kwh.

B. FT Calculation

FT = (FT at tariff schedule) X Fuel (gas/diesel) adjustment factor with base rate.

= 0.45169 x 2.33= 1 0524377 Tk/Kwh..

Tariff rate = OMT + FT = 3.68 Tk/Kwh.

Option –2(Fuel will be Natural Gas)

Contracted minimum from IPPs and the rest from BPDB.

A. OMT Calculation

OMT = (OMT at tariff schedule) x (US dollar-Taka Exchange rate adjustment factor)x 0 99

= 2 056950 x 1.7 x 0.99 = 3.46 Tk/Kwh

OMT (Taka) = (OMT at tariff schedule)x 0.01

= 2 056950 X0.01=0.0205695 Tk/Kwh

Total OMT = 3.48 Tk/Kwh

B. FT Calculation

FT = (FT at tariff schedule) X Fuel (gas/diesel) adjustment factor with base rate

= 0.45169 x 2.33

= 1.0524377 Tk/Kwh

Tariff rate= 4.53 Tk/Kwh

<u>Option –3(Fuel will be Natural Gas)</u>

<u>Sharing on the basis of the past experience</u>.

At 65 per cent plant factor

<u>A. OMT Calculation</u>

OMT = (OMT at tariff schedule) x (US dollar-Taka Exchange rate adjustment factor)x 0.99

= 1.633064 x 1.7 x 0.99 = 2.75 Tk/Kwh

OMT (taka) = (OMT at tariff schedule)x 0.01

= 1.633064 x 0.01

= 0.01633064 Tk/Kwh

Total OMT = 2.77 Tk/Kwh

<u>B. FT Calculation</u>

FT = (FT at tariff schedule) X Fuel (gas/diesel) adjustment factor with base rate.

= 0.54169 x 2.33

= 1.0524377 Tk/Kwh

Tariff rate = OMT + FT = 3.82 Tk/Kwh.

Tariff Rate Calculation for Different Mix with IPPs and BPDB.

(For Lower cost IPPs-Reference AES Meghnaghat)

Option-1

For maximum mix with public & private sector

For all the options we assumed the dependable capacity will 90% of its installed capacity.

At 80% Plant Factor.

a) Capacity Payment for C.C.

i) Non-Escalable CC Capacity Paymenr

CPNEmn =RNECPXCEmXDCm

=4.0969(From Schedul 6 of PPA)X99 28(Value of Dollar)X(360X1000X0.9)

=131783835.17 TK

ii) Escalable Foreign CC Capacity Payment

CPE(US)m = (RECP(US)nXCEmXFIIFqm))XDCm

= 1 2995(From Schedul 6 of PPA)X99.28X1X(360X1000X0 9)

= 41800652.64 TK

CPE(TK)mn = ((RECP)(TK)nXLIIFqn)XDCm

= 7.4132X1X(360X1000X0.9)

= 2401876 80 TK.

CPEmn = CPE(US)m+ CPE(TK)mn

44202529.44 TK.

iii) Capacity Payment :

CPm = CPNEmn + CPEmn

= 175986364 61 TK

b) Energy Payment.

i) Variable O & M

VOMPm = (RVOMPn X CEm X FIIFqm) X NEOh.

= (0.001095 X 99.28 X1) X (360 X 1000 X 0.8 X 744)

= 23293851.96 TK.

ii) Fuel Payment

FPm = TCE hm X (GPn / (0.95 X 1.055))

= ((7397X744 X 360 X 1000 X0.8)/1000000) X (146.47/1 00225)

= 1584969 98X146.14 TK.=231627513.46TK

iii) Energy Payment = VOMPm + FPm

= 23293851 96 + 231627513.46

= 254921365.42 TK.

Tariff Rate will be = ((430907730.03)/(360000 X 0.9 X 744))

= 1.79 TK/ Kwh.

Option-2

For minimum mix with public & private sector

The IPPs(AES Haripur) will run at 50% PF than tariff will be.

a) Capacity Payment for C.C.

i) Non-Escalable CC Capacity Paymenr

CPNEmn =RNECPXCEmXDCm
=4.0969(From Schedul 6 of PPA)X99 28(Value of Dollar)X(360X1000X0.9)
=131783835 17 TK

ii) Escalable Foreign CC Capacity Payment
CPE(US)m = (RECP(US)nXCEmXFIIFqm))XDCm
= 1.2995(From Schedul 6 of PPA)X99 28X1X(360X1000X0 9)
= 41800652.64 TK.
CPE(TK)mn = ((RECP)(TK)nXLIIFqn)XDCm
= 7.4132X1X(360X1000X0.9)
= 2401876.80 TK
CPEmn = CPE(US)m+ CPE(TK)mn
44202529.44 TK

iii) Capacity Payment .

CPm = CPNEmn + CPEmn
= 175986364 61 TK.

b) Energy Payment.

i) Variable O & M
VOMPm = (RVOMPn X CEm X FIIFqm) X NEOh
= (0.001095 X 99.28 X1) X (360 X 1000 X 0.5 X 744)
= 14558657.472 TK.

ii) Fuel Payment.
FPm = TCE hm X (GPn / (0 95 X 1.055))
= ((7397X744 X 360 X 1000 X0 5)/1000000) X (146.47/1 00225)
= 988195.68X146.14 TK.=144414916.68TK.

iii) Energy Payment = VOMPm + FPm
= 14558657.472 + 144414916 68
= 158973574.15 TK.

Tariff Rate will be = ((175986364.61 +158973574 15)/(360000 X 0.9 X 744))
= 1.39 TK/ Kwh.

Option-3

Practically it has been observed that IPPs are allow to run at 60-65% PF. So, we consider 65% PF. Then the charges are as

a) Capacity Payment for C.C.

k) Non-Escalable CC Capacity Paymenr
CPNEmn =RNECPXCEmXDCm
=4.0969(From Schedul 6 of PPA)X99.28(Value of Dollar)X(360X1000X0.9)
=131783835.17 TK

ii) Escalable Foreign CC Capacity Payment
CPE(US)m = (RECP(US)nXCEmXFIIFqm))XDCm
= 1 2995(From Schedul 6 of PPA)X99.28X1X(360X1000X0 9)

= 41800652.64 TK

CPE(TK)mn = ((RECP)(TK)nXLIIFqn)XDCm
= 7.4132X1X(360X1000X0 9)
= 2401876 80 TK.

CPEmn = CPE(US)m+ CPE(TK)mn
44202529.44 TK.

iii) Capacity Payment :

CPm = CPNEmn + CPEmn
= 175986364.61 TK.

h) Energy Payment.

i) Variable O & M
VOMPm = (RVOMPn X CEm X FIIFqm) X NEOh.
= (0.001095 X 99.28 X1) X (360 X 1000 X 0.65 X 744)
= 18926254.71 TK

ii) Fuel Payment

FPm = TCE hm X (GPn / (0.95 X 1 055))
= ((7397X744 X 360 X 1000 X0.65)/1000000) X (146 47/1.00225)
= 1287788.112X146 14 TK =188197354.69TK.

iii) Energy Payment = VOMPm + FPm
= 18926254.71 + 188197354.69
= 207123609 40 TK.

Tariff Rate will be = ((175986364.61 + 207123609.40)/(360000 X 0.9 X 744))
= 1.59 TK/ Kwh.

Option-4: Special Consideration.
If we consider that higher tariff charge IPPs are not allow to generate any power and lower rate IPPs are allow to generate its maximum capability and remaining will be fulfill by BPDB,s own generation than the tariff rate will be as below In this option higher tariff rate IPPs are allow to get OMT charge as per the contracted agreement Consider the granted capacity will be 90% of its installed capacity.

OMT calculation

OMT = OMT Adjusted x Exchange rate x 0.99.
= 1.548 x1 7x0.99 = 2.605 Tk/Kwh
OMT (taka) = OMT Adjusted x 0 01=1.548 x0 01 =0.01548 Tk/Kwh.
Total OMT (taka) = 2.604 + 0.01548 = 2.62 Taka/ Kwh.
Minimum Energy Payment(MEP)= Total OMTX (Granted capacity)GC
= 2.62 X (725X0.9X1000X744)
=1003931280.00TK for a month.

For lower tariff charge IPPs
a) Capacity Payment for C C
I) Non-Escalable CC Capacity Paymenr

CPNEmn =RNECPXCEmXDCm
=4.0969(From Schedul 6 of PPA)X99.28(Value of Dollar)X(1215X1000X0.9)
=444770443.69 TK

ii) Escalable Foreign CC Capacity Payment
CPE(US)m = (RECP(US)nXCEmXFIIFqm))XDCm
= 1.2995(From Schedul 6 of PPA)X99 28X1X(1215X1000X0.9)
= 141077202.66 TK.
CPE(TK)mn = ((RECP)(TK)nXLIIFqn)XDCm
= 7.4132X1X(1215X1000X0.9)
= 8106334.2 TK.
CPEmn = CPE(US)m+ CPE(TK)mn
=141077202.66+ 8106334.2 TK.=22183536.86TK.

iii) Capacity Payment .

CPm = CPNEmn + CPEmn
= (444770443.69 +22183536.86)TK.
= 466953980.55TK

b) Energy Payment.

i) Variable O & M
VOMPm = (RVOMPn X CEm X FIIFqm) X NEOh.
= (0.001095 X 99.28 X1) X (360 X 1000 X 0.9 X 744)
= 88443844.14 TK.

ii) Fuel Payment.
FPm = TCE hm X (GPn / (0.95 X 1.055))
= ((7397X744 X 1215 X 1000 X0 9)/1000000) X (146.47/1.00225)
= 879460715.18TK.

iii) Energy Payment = VOMPm + FPm
= 88443844.14 + 879460715.18
= 967904559.32TK.

Tariff Rate will be = ((466953980.55 + 967904559.32)/(1215X1000X 0.9 X 744))
= 1434858539.86/(1215X1000X.9X744)TK/ Kwh.
=1.76 TK/Kwh

System total with

For Option-1.
(580/5989)X3.68 +(972/5989)X1.79 +(4437/5989)X2 4
=.09X3.68 + 16X1.79 +.74X2.4
=.3312 +.2864+1.776
=2.39 TK/Kwh.

For Option-2.
(362.5/5989)X4.53 +(607 5/5989)X1 39 +(5019/5989)X2.4
=.06X4.53 +.10X1.39 +.84X2 4
=.2718 +.139+2.01
=2.42 TK/Kwh.

For Option-3.

(471/5989)X3.82 +(790/5989)X1 59 +(4728/5989)X2.4

= 078X3 82 +.13X1.59 +.79X2 4

= 30 +.2067+1.89

=2 39 TK/Kwh.

For Option-4 Special Option.

Total payment

=(1215X1000X1.76X744+4856X1000X2.4X744+1003931280.00)TK

=(1590969600+8670873600+1003931280)

=11265774480TK

System total=11265774480/4471626000

=2.52 TK/Kwh.

<u>Appendix-1 to</u>
<u>Annexture 'D' to</u>

SCHEDULE 6
REFERENCE TARIFFS

<u>Table 1 Reference Tariff</u>

Agreement Year	Reference Capacity Price			Reference Energy Charge	
	Reference Non-Escalable Capacity Price (Dollar/kW-Month)	Reference Foreign Capacity Price (Dollar/kW-Month)	Reference Local Capacity Price (Taka/Kw-Month)	Reference Variable Operation and Maintenance Price (Dollar/kW)	Reference Fuel Price (Taka/kWh) (See Note 1)
1	4.4480	1.2995	7.4132	0.001095	
2	4.3700	1.2995	7.4132	0.001095	
3	4.3001	1.2995	7.4132	0.001095	
4	4.2313	1.2995	7.4132	0.001095	
5	4.1636	1.2995	7.4132	0.001095	
6	4.0969	1.2995	7.4132	0.001095	
7	4.0314	1.2995	7.4132	0.001095	
8	3.9669	1.2995	7.4132	0.001095	
9	3.9034	1.2995	7.4132	0.001095	
10	3.8410	1.2995	7.4132	0.001095	
11	3.8410	1.2995	7.4132	0.001095	
12	3.8410	1.2995	7.4132	0.001095	
13	3.7641	1.2995	7.4132	0.001095	
14	3.6889	1.2995	7.4132	0.001095	
15	3.6151	1.2995	7.4132	0.001095	
16	2.5306	1.2995	7.4132	0.001095	
17	1.7714	1.2995	7.4132	0.001095	
18	1.2400	1.2995	7.4132	0.001095	
19	0.8680	1.2995	7.4132	0.001095	
20	0.6076	1.2995	7.4132	0.001095	
21	0.4253	1.2995	7.4132	0.001095	
22	0.0000	1.2995	7.4132	0.001095	

Note: The Reference Fuel Price shall be the price payable by BPDB for one (1) kWh of Net Electrical Output based on the Reference Heat (provided in Table 2) corresponding to a particular Plant Factor (as a % of Dependable Capacity) calculated over a half hour interval and based on the then prevailing Gas price as provided in Section 10.

Appendix-2 to
Annexture 'D'

Table 1 Reference Heat Rates

Plant Load (LP_h) (% of Dependable Capacity) (See Note: 1)	Reference Heat Rates (kJ/kWh) (HHV)
100%	7336
95%	7364
90%	7397
85%	7435
80%	7490
75%	7566
70%	7668
65%	7810
60%	7991
55%	8214
50%	8485
45%	8809
40%	9191

Note: 1 Reference Heat Rates shall be interpolated for Plant Factors between the specified points above